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16. ABSTRACT

This document provides information which establishes a technical basis for understanding the major differences between the original section 301 (h) regulations promulgates in 1979 and 1982 amended regulations. This document also provides a technical explanation of assessments required for obtaining section 301 (h) modified discharge permits and guidance for both small and large POTWs to use in completing the appropriate application questionaire. This document supersedes the original (1979) Technical Support Document. However, the technical informaiton provided by that document is still relevant and useful. This guidance is advisory only; its use is not required.

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November, 1982

by

Tetra Tech, Inc., Staff

Contract Number 68-01-5906

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EPA REVIEW NOTICE

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This report has been reviewed by the Office of Water Program Operations and the Office of Research and Development, U.S. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

Section 301(h) of the Clean Water Act provides publicly owned wastewater treatment works (POTWs) an opportunity to apply for variances from secondary treatment requirements for discharges to marine waters. This Technical Support Document supplements the section 301(h) regulations as amended in November, 1982 (40 CFR Part 125, Subpart G). This document provides information which establishes a technical basis for understanding the major differences between the original section 301(h) regulations promulgated in 1979 and the 1982 amended regulations. This document also provides a technical explanation of assessments required for obtaining section 301(h) modified discharge permits and guidance for both small and large POTWs to use in completing the appropriate application questionnaire. This document supersedes the original (1979) Technical Support Document. However, the technical information provided by that document is still relevant and useful.

The guidance provided in this Technical Support Document is advisory only; its use is not required. However, EPA believes that section 301(h) applicants will benefit substantially by following the guidance and procedures provided in this document to demonstrate they have satisfied requirements of section 301(h) and 40 CFR Part 125, Subpart G.

This document has incorporated a number of changes which were made to the Draft Technical Support Document released in May, 1982. Some of the significant modifications are listed below.

TSD MODIFICATIONS MAY, 1982 -- NOVEMBER, 1982

I. Introduction

- Brief reference to the 1981 U.S. Court of Appeals decision was added

- Applicant questionnaire flow chart was clarified

II. Description of Assessments

- Reference to "available supply of dilution water" has been deleted

III. Small Applicant Questionnaire

- Qualifying flow requirement for "small applicant" status has been clarified to read "projected average dry weather flow at the end of the permit period of less than 5 MGD" (see, Question II.A.4.b)

- Conditions under which small applicants should conduct more detailed analyses and/or provide more information than requested in the small applicant questionnaire are clarified

- The guidance associated with Question II.B.1 has been modified to clarify that the 25 ppt salinity test is general only and not an absolute requirement

- Questions II.B.4.a and III.E.2 have been modified to request discussion of fecal coliforms

- Question II.D.3 has been clarified to more accurately specify the information being sought

- Use of Figures III-3 and III-4 has been clarified and new figures provided

- Guidance associated with questions III.H.2 and III.H.4 has been clarified

IV. Large Applicant Questionnaire

- Definition of flow requirement for large applicants has been clarified (see, Question II.A.4.b)
- Reference to requirements for revised applications has been added
- The guidance associated with Question II.B.1 has been modified to clarify that the 25 ppt salinity test is general only and not an absolute requirement
- Questions II.B.5.a, and III.E.2 have been modified to request discussion of fecal coliforms
- The guidance associated with Question II.C.1 has been clarified
- Question II.D.3 has been clarified to more accurately specify the information being sought
- Proposed Question III.A.2 (regarding dilution water supply) has been deleted

V. Physical Assessment

No significant changes.

VI. Water Quality Assessment

- Table VI-3 has been corrected
- Equation VI-12 has been corrected
- Figure VI-4 has been corrected
- Equation VI-24 has been corrected

- Equation VI-29 has been corrected
- Equation VI-30 has been corrected
- Table VI-12 has been modified to include only potable water supply facilities.

VII. Marine Biological Assessment

No changes.

VIII. Toxic Substance Control Programs

- Reference to toxic pollutants and pesticides has been corrected to 40 CFR 125.58 (v) and (m)
- Table VIII-1 has been replaced.

IX. Monitoring Programs

No changes.

X. Plan of Study

No changes.

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I. INTRODUCTION

BACKGROUND

The Clean Water Act of 1977 included provisions under section 301(h) which allow POTWs to apply for a modified National Pollutant Discharge Elimination System (NPDES) permit to discharge effluent receiving less-than-secondary treatment to marine waters. Section 301(h) provides that the Administrator of the Environmental Protection Agency (EPA), with the concurrence of the State, may issue an NPDES permit to a POTW which modifies the Federal secondary treatment requirements for POTW discharges into certain ocean or estuarine waters if the POTW adequately demonstrates that the modification would not impair the integrity of the marine receiving waters and biota. Regulations implementing section 301(h) were first issued by EPA in June, 1979 (44 FR 34784, 40 CFR Part 125, Subpart G).

The June 15, 1979, regulations were challenged in the United States Court of Appeals for the District of Columbia Circuit by the Natural Resources Defense Council, Inc. (NRDC), the Pacific Legal Foundation, Inc. (PLF), the municipalities of Skagway, Wrangell, and Anchorage, Alaska, and the Marina County Water District, California. On May 7, 1981, the court struck down the provisions of EPA's regulations which prohibited issuance of section 301(h) modified permits:

1. For a discharge receiving less than primary treatment

2. For the discharge of sewage sludge

3. Where the applicant is currently meeting effluent limitations based on secondary treatment.

Subsequent to the Court's decision, section 301(h) was amended by the Municipal Wastewater Treatment Construction Grant Amendments of 1981 (P.L. 97-117) and now specifies that:

"The Administrator, with the concurrence of the State, may issue a permit under Section 402 which modifies the requirements of subsection (b)(1)(B) of this section with respect to the discharge of any pollutant from a publicly owned treatment works into marine waters, if the applicant demonstrates to the satisfaction of the Administrator that-

(1) there is an applicable water quality standard specific to the pollutant for which the modification is requested, which has been identified under Section 304(a)(6) of this Act;

(2) such modified requirements will not interfere with the attainment or maintenance of that water quality which assures protection of public water supplies and the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife, and allows recreational activities, in and on the water;

(3) the applicant has established a system for monitoring the impact of such discharge on a representative sample of aquatic biota, to the extent practicable;

(4) such modified requirements will not result in any additional requirements on any other point or nonpoint source;

(5) all applicable pretreatment requirements for sources introducing waste into such treatment works will be enforced;

(6) to the extent practicable, the applicant has established a schedule of activities designed to eliminate the entrance of toxic pollutants from nonindustrial sources into such treatment works;

> (7) there will be no new or substantially increased discharges from the point source of the pollutant to which the modification applies above that volume of discharge specified in the permit;
>
> For the purposes of this subsection the phrase 'the discharge of any pollutant into marine waters' refers to a discharge into deep waters of the territorial sea or the waters of the contiguous zone, or into saline estuarine waters where there is strong tidal movement and other hydrological and geological characteristics which the Administrator determine necessary to allow compliance with paragraph (2) of this subsection and section 101(a)(2) of the Act. A municipality which applies secondary treatment shall be eligible to receive a permit pursuant to this subsection which modifies the requirements of subsection (b)(1)(B) of this section with respect to the discharge of any pollutant from any treatment works owned by such municipality into marine waters. No permit issued under this subsection shall authorize the discharge of sewage sludge into marine waters."

Seventy final applications for section 301(h) variances were received under the 1979 section 301(h) regulations. The experience gained by EPA since 1979 from evaluating these applications has helped to identify a number of areas where the section 301(h) regulations and application data requirements can be effectively streamlined. The size of the POTW discharge was found to play an important role in impacting the water quality and biological communities of the receiving waters. As a result, it was determined that application data requirements and associated costs for small section 301(h) applicants can be reduced.

The EPA has therefore, amended the regulations implementing section 301(h) to reflect the 1981 court case, the 1981 legislated changes, and EPA's experience in implementing this program. As a result, the regulations and application requirements have been made simpler, clearer, and more flexible.

This document provides technical support for the major changes made in the section 301(h) regulations since 1979 and provides technical guidance to applicants, both small and large, for use in responding to the appropriate application questionnaire when completing their section 301(h) applications. An additional document entitled "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters" (Tetra Tech 1982) provides information related to monitoring programs.

EXPERIENCE TO DATE

The section 301(h) applications reviewed to date encompass a wide variety of geographic locations, receiving water conditions and discharge characteristics. Geographically, applications were filed from Hawaii, the Virgin Islands, Puerto Rico, Alaska, and the continental East and West Coasts. Applicant discharges were located in estuaries, along open coastlines, and in coastal embayments. Table I-1 illustrates the range of discharge characteristics observed.

The quality of applicant effluents, expressed as effluent limitations, also covered a wide range. Maximum average biochemical oxygen demand (BOD_5) concentrations ranged from 40 to 350 mg/l. Maximum average suspended solids concentrations ranged from 31 to 150 mg/l. Effluent limitations for pH were all within the range of 6.0 to 9.0.

Toxic substances observed in applicant POTW effluent samples that were projected to exceed EPA water quality criteria after critical initial dilution were:

- Cadmium
- Chlordane
- Chlorinated benzenes
- Copper
- Cyanides
- DDT
- Endrin
- Ethylbenzene
- Heptachlor
- BHC Isomers
- Lead
- Mercury
- Nickel
- PCBs
- Pentachlorophenol
- Selenium
- Silver
- Zinc

TABLE I-1. RANGE OF DISCHARGE CHARACTERISTICS OF REVIEWED SECTION 301(h) APPLICATIONS

Characteristic	Range of Characteristics Minimum	 Maximum
Average discharge, m^3/sec	0.06	25.20
(MGD)	(1.4)	(575)
Discharge depth, m	2.4	70.1
(ft)	(8)	(230)
Minimum initial dilution	2.3:1	147:1
Average mass emissions rate, kg/day (lb/day)		
BOD_5	410 (904)	161,780 (356,770)
Suspended solids	410 (904)	275,000 (606,000)

Although data were not available to distinguish between industrial and nonindustrial sources, it is suspected that industrial discharges to the POTWs were the primary source of observed priority pollutants. Industrial inflows ranged from 0 to 30 percent of average plant discharge. All cases of projected toxic organic compound concentrations greater than EPA water quality criteria after critical initial dilution occurred at plants with average discharges greater than 0.22 m^3/sec (5 MGD) and industrial contributions greater than 5 percent. It is important to note that none of the applicants had fully implemented industrial pretreatment programs under 40 CFR Part 403 at the time of application. Significant reductions of priority pollutant and pesticide concentrations in applicant effluents are expected once industrial pretreatment programs are in effect.

Compliance with applicable water quality standards for dissolved oxygen and suspended solids is a primary concern of section 301(h). All states with section 301(h) applicants have standards establishing minimum dissolved oxygen concentrations to be maintained following initial dilution as well as surrogate standards for suspended solids such as light transmittance or turbidity. Noncompliance with dissolved oxygen standards under worst-case conditions was indicated in only a few cases. In some of these cases, ambient dissolved oxygen concentrations were only a few tenths of a mg/l above applicable water quality standards and, thus, even small dissolved oxygen depressions would cause noncompliance. The largest observed dissolved oxygen depression after initial dilution was 1.5 mg/l. In all other cases, the depression beyond the zone of initial dilution was less than 1 mg/l. No clear cases of suspended solids standards noncompliance were indicated. While the impact of suspended solids in the water column was found to be minimal, the impact of solids and associated toxic substance accumulation on the seabed was found to be the single most significant environmental impact related to municipal discharges to the marine environment.

Of the marine communities which may be affected by POTW discharges, the benthic communities or other communities depending upon the benthos as a food source (i.e., bottom-dwelling or bottom-feeding organisms) are usually the most sensitive to pollutants. The rate of accumulation of discharged solids and associated toxic substances near a POTW outfall affects the magnitude and extent of impacts on benthic communities. Based on the review of biological conditions near both large and small discharges in a variety of marine and estuarine environments, it is apparent that the effects of POTW discharges on the benthos are determined primarily by the influence of the local hydrographic regimes on solids deposition and accumulation. Observed biological effects in areas of solids accumulation were generally associated with decreased abundances of suspension-feeding animals and increased abundances of deposit-feeding animals. Such effects would be expected to occur in sediments enriched with organic matter.

Some of the largest POTW discharges evaluated [larger than 100 million gallons per day (100 MGD)] were located in relatively deep waters (about 60 m) in open coastal environments. These outfalls also had well-designed diffusers and high initial dilutions (about 100:1). Nevertheless, effects on benthic communities near most of the largest discharges were shown to occur over relatively large areas, ranging from about 10 to 100 square kilometers (km^2) as measured by some biological variables. Effects on the benthos were also predicted to extend over areas of about 4 to 10 km^2 after discharge improvements. The extent of impacts for the larger discharges has been shown to be correlated to the discharge rate of total solids. For outfalls in similar receiving water environments, the greatest areal extent of modified benthic communities was detected near the discharge with the highest mass emission rate of total suspended solids. The ameliorating influence of relatively high ambient currents on benthic effects was indicated at a large estuarine discharge at which there was no evidence of widespread domination of benthic communities by deposit-feeders despite a relatively high solids emission rate.

Studies conducted near discharges with flow rates between 10 and 70 MGD generally did not have sufficient numbers of sampling stations to define the areal extent of effects on the benthos. Available studies indicated an apparent absence of highly modified benthic communities near several intermediate-sized discharges, one of which is located in an estuarine area of very high flushing characteristics and the others in open coast environments. In cases where apparent effects were detected at these sites with high dispersion characteristics, the effects were expressed only as moderate changes in benthic species composition in areas very near the discharges. Apparent adverse effects on benthic communities were detected, however, at several discharges in this intermediate discharge category, all of which are located in relatively protected environments (i.e., embayments) on the continental shelf of the Atlantic coast. In such cases, benthic communities near the discharges were dominated by pollution-tolerant or opportunistic species.

Evaluation of discharges from small POTWs (less than 5 MGD) has indicated a general absence of adverse impacts on benthic communities. Two categories of smaller discharges have been evaluated: 1) discharges in open coast environments at water depths of 12 to 28 m and distances of 600 to 1,800 m offshore; and 2) discharges located in highly flushed estuarine environments at depths of 25 to 27 m and distances of 150 to 200 m offshore. In both of these types of environments there was an apparent absence of localized solids accumulation near the discharges. In most cases ambient sediment particle sizes were relatively large (sand to cobble), indicating that natural tidal currents or wave-induced currents resulted in dispersion of discharged particulates. Wave-induced resuspension may have been especially important in preventing localized accumulation near two discharges located at depths of 12 to 13 m. The solids emission rates were also relatively small, resulting in a lower potential for impact on the benthos.

Although as a result of higher current speeds the potential for localized solids accumulation would decrease with decreasing depth in an open coast environment, there would be an associated increase in the potential for other adverse effects. These effects include increased potential for contaminating recreational beaches or intertidal shellfish resources for discharges into nearshore environments. In addition, the potential impacts on productive intertidal or shallow subtidal habitats (e.g., rocky intertidal, coral reefs, kelp beds, or seagrass beds) would be higher in the case of nearshore discharges. None of the small discharges evaluated were located in nearshore, shallow water habitats (water depth less than 10 m) with limited dispersion potential (e.g., embayments). Hence, discharges to nearshore waters are of concern due to their higher potential for impact and the lack of previously evaluated sites which would form a predictive information base.

The distribution of demersal or bottom-feeding fishes can also be affected by accumulation of solids near POTW discharges. Such fish species have sediment preferences and may either avoid or be attracted to organically enriched sediments. Generally, demersal and certain bottom-feeding fishes feed on invertebrates in or on the sediment. Thus, changes in the availability of these preferred food species can also result in secondary impacts on the distribution of demersal or bottom-feeding fishes distributional patterns.

At some of the largest discharges evaluated, bottom trawl surveys have indicated changes in demersal fish abundances expressed as higher numbers of some species (e.g., Dover sole) and lower numbers of others (e.g., longspine combfish). Based on the apparent lack of localized solids accumulation and lack of highly modified benthic invertebrate communities near the smaller discharges evaluated, it is reasonable to assume that demersal fish abundances would not be greatly altered.

The accumulation of discharged solids contaminated by toxic substances can have additional effects on benthic invertebrates and demersal fishes. Physical contact with contaminated sediments or ingestion of contaminated prey or sediments can result in bioaccumulation of toxic substances or induction of diseases. Both of these effects have been observed near very large discharges (greater than 100 MGD) that have historically discharged large quantities of toxic substances. Evidence of bioaccumulation of toxic substances also exists for the intermediate-sized discharges located in limited dispersion areas. These are the same sites at which modified benthic invertebrate communities were indicated by substantial accumulations of discharged solids near the discharge.

With one exception, bioaccumulation of toxic substances has not been directly assessed near smaller section 301(h) applicant discharges. However, none of the applications submitted with flow rates less than 5 MGD had significant industrial contributions to their flow. The potential for adverse bioaccumulation is considerably less at small discharge sites analyzed because of the apparent lack of effluent-derived solids accumulation near discharges with flows less than 5 MGD located in areas of high dispersion and the low quantities of toxic substances in effluents containing primarily domestic wastes. Discharges located in shallow, semi-enclosed environments would have a greater potential for causing adverse bioaccumulation, especially if relatively large quantities of toxic substances occurred in the effluent.

Effects of marine POTW discharges on plankton communities have been evaluated primarily at the largest discharges. Some evidence of elevated primary productivity was observed near some outfalls, but no direct adverse effects on phytoplankton have been observed, although indirect ecological impacts may occur in certain cases. The lack of apparent adverse impacts on open coast phytoplankton communities, even for the largest discharges, is consistent with the relatively high effluent dispersion characteristics in these areas. Moderate elevations in primary productivity or algal standing crop may be considered as beneficial or neutral effects if they do not result in secondary effects such as substantial dissolved oxygen depressions, fish kills or stimulation of nuisance or toxic phytoplankton blooms.

Effects of POTW discharges on plankton communities in shallow estuaries or embayments have not been evaluated. These areas with limited flushing characteristics represent a relatively high potential for adverse impacts on phytoplankton when compared with the open coast environments.

The above findings have allowed significant conclusions with regard to the necessity for data collection and field studies by small section 301(h) applicants. Applications which have been reviewed include a wide range of geographic locations and flow rates. Sources of toxic substances appear to be primarily related to industrial flows and very few small discharges reviewed had toxic substances concentrations which, after initial dilution, would exceed water quality criteria. Benthic community and demersal fish studies indicated that effects were observed when there was significant solids accumulation, but such effects are not expected in the absence of solids accumulation. Most small discharges at depths greater than 10 m are not expected to result in substantial solids accumulation. Receiving water quality standards were not violated except under unusual conditions. As a result of these findings, small discharges (without substantial industrial inflows) to depths greater than 10 m into well-mixed receiving waters are not expected to have adverse effects on the receiving water ecosystem. Consequently, specific, onsite field surveys and related, detailed analyses generally are not necessary for such small applicants to demonstrate the absence of adverse effects on the marine environment. Monitoring also should be necessary only to determine compliance with applicable water quality standards and to address any identified or potential receiving water and biological habitat problems.

REGULATORY CHANGES

EPA has amended the original (1979) section 301(h) regulations to make them simpler, clearer, and more flexible. While many of the amendments are procedural in nature, others are focused on avoiding unnecessary expenditure of applicant resources and the collection of unnecessary data. All applicants are encouraged to use existing data where possible in responding to the data and technical evaluation requirements in the questionnaires. Where existing data are not sufficient, applicants are encouraged to develop a plan of study in consultation with EPA and to collect the necessary additional data as support for completed applications before the application deadline of December 29, 1982. After the deadline, plans of study are required and additional data collection for supplementing an application can be done only as authorized or requested by EPA [40 CFR 125.59(f)].

Some of the regulation amendments either simplify the actual data requirements or increase the flexibility that applicants are allowed in meeting the requirements, or both. In the case of the monitoring program and toxics control program requirements, the basic structure and objectives of the regulatory requirements remain the same but more flexibility is provided for achieving the objectives of those requirements. In addition, some of the specific data requirements of the regulations have been simplified or deleted for small applicants based on the findings and conclusions that have resulted from EPA's experience in evaluating existing section 301(h) applications. The amendments lead to a different approach in dealing with small applicants that can certify they have no known industrial sources of toxic pollutants, discharge into waters with good flushing and dispersion characteristics, and do not impact areas of special biological, commercial, or recreational concern.

As defined in the amended regulations, a section 301(h) modified permit may be based on current, improved or altered discharge characteristics [40 CFR 125.58(j)]. Discharge improvements may include collection system, treatment plant, and/or outfall improvements and relocations. Altered discharges include those proposing a treatment level less than that currently achieved, resulting in downgrading of effluent characteristics with or without outfall improvements/relocations to compensate for the lower effluent quality. Therefore, under the amended regulations, applicants may propose any treatment level (including no treatment).

A separate application questionnaire is provided for small POTWs (those with service area populations less than 50,000 and discharging under 5 MGD [40 CFR 125.58(c)]) who may submit a more streamlined application than either large applicants (those with service area populations equal to or greater than 50,000 or discharging 5 MGD or more [40 CFR 125.58(c)]) or small applicants with known industrial sources of toxics, discharging in waters with poor mixing and dispersion characteristics, or with potential impacts on areas of special biological, commercial, or recreational importance. Although the same basic determinations are required of both large and small applicants (that is, the same types of questions are asked and the same information and analyses are requested by both the Small and Large Applicant Questionnaires), the questions and data/analytical requirements are less complicated for those small applicants with low potential for violation of water quality standards and low potential for adverse impacts on areas of biological, recreational, or commercial importance. The Large Applicant Questionnaire includes several questions that are not included in the Small Applicant Questionnaire. These additional questions supplement the more general questions of the Small Applicant Questionnaire and seek more detailed data in certain areas. Table I-2 describes how the additional questions asked in the Large Applicant Questionnaire are covered by the more general questions of the Small Applicant Questionnaire.

GUIDANCE ORGANIZATION

Figure I-1 shows how this document is organized to help small and large applicants to complete their respective section 301(h) application questionnaires.

Figure I-1 shows how potential section 301(h) applicants are categorized as small or large depending on their POTW service area population and discharge design flow. Small dischargers/applicants are directed to Chapter III of this document and large dischargers/applicants to

TABLE I-2. RELATIONSHIP OF ADDITIONAL LARGE APPLICANT QUESTIONS TO SMALL APPLICANT QUESTIONS

Large Applicant Questionnaire Question	
II.B.4.	Oceanographic conditions description is covered in the Small Applicant Questionnaire by question II.B.3.
II.B.6.	Data on sediment related dissolved oxygen is covered in the Small Applicant Questionnaire by question II.B.4.
II.C.1.	Description of biological communities is covered in the Small Applicant Questionnaire by question II.C.1.
III.A.4.	Effects of currents and dispersion is covered in the Small Applicant Questionnaire by question III.A.3.
III.B.3.	Dissolved oxygen depression related to sediments is covered in the Small Applicant Questionnaire by question III.B.4.
III.B.5.	Change in pH is covered in the Small Applicant Questionnaire by question III.B.4.
III.D.4.	Related to adverse biological impacts is covered in the Small Applicant Questionnaire by question III.D.1, 2, and 3.

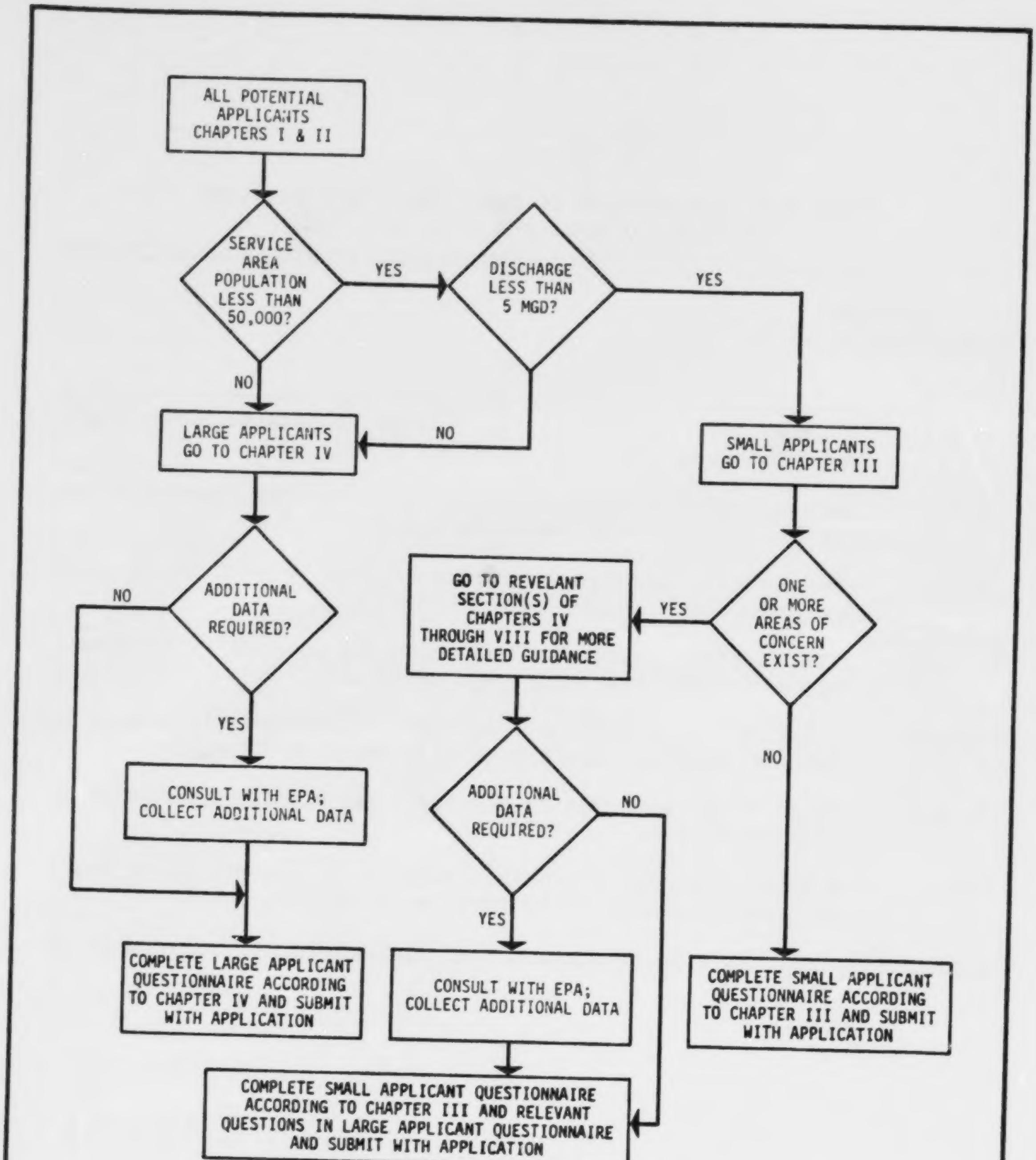

ALL POTENTIAL APPLICANTS CHAPTERS I & II
SERVICE AREA POPULATION LESS THAN 50,000?
YES
DISCHARGE LESS THAN 5 MGD?
YES
NO
NO
LARGE APPLICANTS GO TO CHAPTER IV
SMALL APPLICANTS GO TO CHAPTER III
NO
ADDITIONAL DATA REQUIRED?
GO TO REVELANT SECTION(S) OF CHAPTERS IV THROUGH VIII FOR MORE DETAILED GUIDANCE
YES
ONE OR MORE AREAS OF CONCERN EXIST?
YES
NO
CONSULT WITH EPA; COLLECT ADDITIONAL DATA
ADDITIONAL DATA REQUIRED?
NO
YES
COMPLETE LARGE APPLICANT QUESTIONNAIRE ACCORDING TO CHAPTER IV AND SUBMIT WITH APPLICATION
CONSULT WITH EPA; COLLECT ADDITIONAL DATA
COMPLETE SMALL APPLICANT QUESTIONNAIRE ACCORDING TO CHAPTER III AND SUBMIT WITH APPLICATION
COMPLETE SMALL APPLICANT QUESTIONNAIRE ACCORDING TO CHAPTER III AND RELEVANT QUESTIONS IN LARGE APPLICANT QUESTIONNAIRE AND SUBMIT WITH APPLICATION

Figure I-1. Section 301(h) Applicant Questionnaire Flow Chart.

Chapter IV, for specific guidance on completing their application questionnaires. The questionnaires are organized into two major sections; 1) general information and basic data requirements, and 2) technical evaluation. Applicants are required to complete both sections of the appropriate questionnaire for determining compliance with section 301(h) criteria and related regulatory requirements [40 CFR 125.59(c)].

It is expected that most small applicants will be able to complete the questionnaire using available data. Some small applicants will find, however, that their discharge or receiving water circumstances include special areas of concern such as:

- A discharge with low initial dilution
- Receiving waters with poor dispersion and transport characteristics
- A discharge near distinctive and/or susceptible biological habitats
- A discharge with substantial quantities of toxic pollutants or pesticides.

Such applicants are referred by the guidance in Chapter III to specified later chapters of this document for more detailed guidance. They are required to answer the relevant questions of the related sections in Parts II and III of the large applicant questionnaire. Table I-2 can help direct such small applicants to the relevant questions in Parts II and III of the large applicant questionnaire. If such applicants determine the need for additional data collection, they are encouraged to prepare a plan of study and consult with EPA before collecting the additional data and submitting the data with their applications.

II. DESCRIPTION OF ASSESSMENTS

Assessing the effects of POTW discharges into the marine environment involves physical, water quality, and biological evaluations. Possible effects on public water supplies and recreational activities must also be assessed as directed by section 301(h) of the Clean Water Act. Section 301(h) also requires that appropriate consideration be given to effluent, receiving water, and biological monitoring; control of toxic substances; and possible interactions with other pollutant sources. This section provides a discussion of the important processes such as dilution, dispersion, dissolved oxygen consumption, and sedimentation, which occur in the receiving waters and the types of assessments which are made to determine compliance with section 301(h) requirements. This document addresses the relative importance of these processes as they occur in different receiving water environments, such as open coastlines, embayments, and saline estuaries.

PHYSICAL ASSESSMENT

POTW effluents are normally discharged into marine waters through outfalls that range from open-ended pipes to extensive diffusers. The characteristics of the effluent and the receiving water, the diffuser design, and the depth of discharge will determine the amount of effluent dilution achieved. As shown in Figure II-1, the lower-density (non-saline) discharge/effluent creates a buoyant plume that rises rapidly toward the water surface, entraining significant amounts of ambient saline water. The momentum and buoyancy of the discharged effluent are primarily responsible for the entrainment of dilution water (mixing of ambient saline water with effluent). As the plume rises and entrains ambient saline water (dilution water), its density increases and its momentum and buoyancy decreases accordingly. If a sufficient ambient vertical density gradient or zone of stratification (like a pycnocline or thermocline) is present, the plume will spread horizontally at the level of neutral buoyancy (i.e., plume density equals ambient water density). If a sufficient density gradient is not

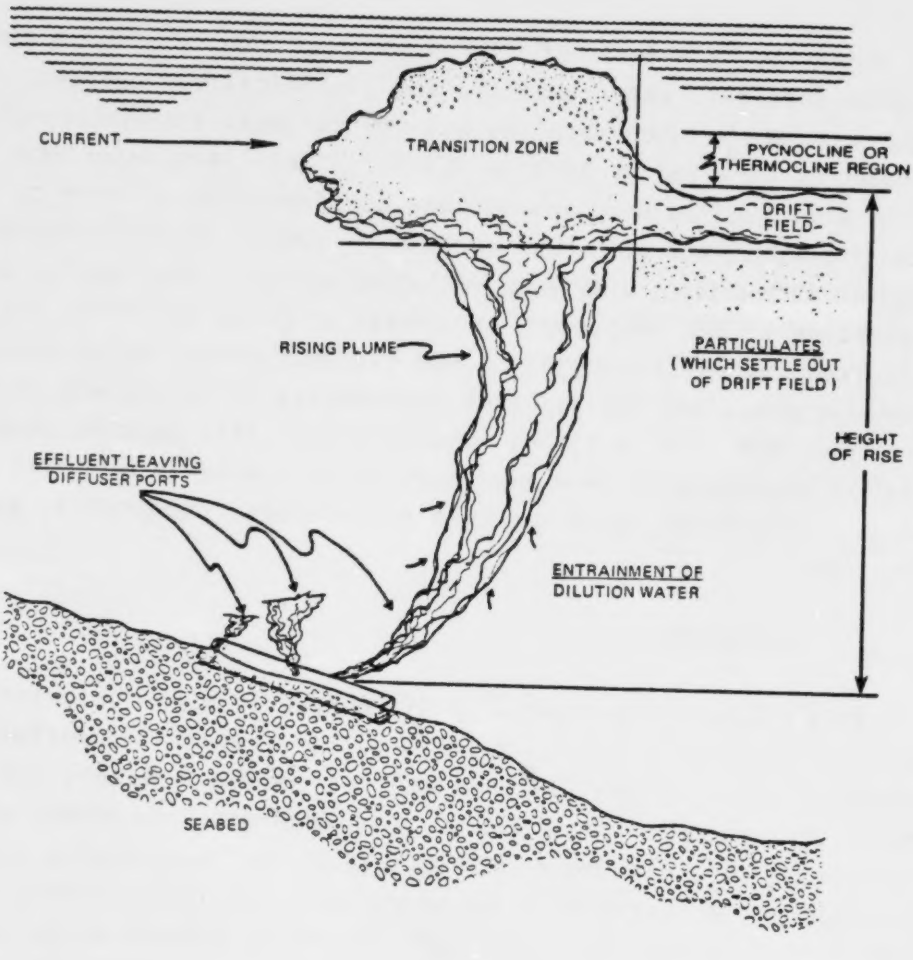

CURRENT
TRANSITION ZONE
PYCNOCLINE OR THERMOCLINE REGION
DRIFT-FIELD-
RISING PLUME
PARTICULATES (WHICH SETTLE OUT OF DRIFT FIELD)
HEIGHT OF RISE
EFFLUENT LEAVING DIFFUSER PORTS
ENTRAINMENT OF DILUTION WATER
SEABED

Figure II-1. Wastefield generated by simple ocean outfall.

present, the diluted effluent will reach the water surface and flow horizontally. The vertical distance from the discharge point(s) to the centerline of the plume when it reaches the level of neutral buoyancy or the water surface is called the "height of rise" (sometimes referred to as the heights to "trapping" or "equilibrium" level).

The dilution achieved at the completion of this process is called the "initial dilution." Dilution is the ratio of the total volume of a sample (ambient water plus effluent) to the volume of effluent in the sample. A dilution of 100 to 1 is, therefore, a mixture composed of 99 parts of ambient water to 1 part of effluent. The initial dilution is a critical parameter relative to compliance with water quality standards and is thus discussed in some detail in the evaluation of both large and small applications. The magnitude of initial dilution achieved is dependent on ambient density gradients and diffuser design.

The "zone of initial dilution" (ZID) is the volume of water and underlying seabed in which this initial dilution process occurs. The ZID size is important in determining compliance with water quality and biological criteria. This guidance document provides a method which can be used to determine the size of the ZID.

The transport of the diluted effluent beyond the ZID is also important in determining if a discharge will comply with water quality standards. In addition, dischargers to estuaries or partially enclosed (or restricted flow) areas may need to demonstrate that re-entrainment or accumulation of effluent will not result in violation of applicable water quality standards.

WATER QUALITY ASSESSMENT

The discharge of effluent can affect the receiving water quality in a number of ways depending on effluent quantity and composition, the receiving water conditions, and the dilutions achieved. Water quality assessment variables of primary concern in the section 301(h) decisionmaking process are dissolved oxygen, suspended solids, and pH. However, any other variables subject to applicable water quality standards are also of concern. Dissolved oxygen in the receiving water is diminished as a result of the "immediate dissolved oxygen demand" (IDOD) within the ZID and oxidation of organic material in the diluted effluent beyond the ZID. Dissolved oxygen demand caused by oxidation of effluent organic material is referred to as "biochemical oxygen demand" (BOD_5). The section 301(h) assessment procedures involve determination of dissolved oxygen levels (or depression) beyond the ZID due to BOD_5 and as a result of accumulated sediment oxygen demand. This assessment requires knowledge of the effluent characteristics, receiving water dissolved oxygen concentrations, and accumulated sediment characteristics. Suspended solids which accumulate on the seabed may exert a dissolved oxygen demand as a result of continuous oxidation of sediment surface organic material plus rapid, periodic oxidation of resuspended sediments. Rates of suspended solids accumulation are calculated based on discharge rates, settling characteristics, and oceanographic conditions such as currents and density stratification that affect dispersion and transport of discharged effluent solids.

In addition to potential effects on receiving water dissolved oxygen of effluent solids that accumulate on the seabed, suspended solids in the water column may reduce light transmittance and thus water clarity. Reduction of the depth to which available sunlight penetrates may also affect biological communities within the water column.

The pH of the receiving water can be affected as a result of the discharge of either highly acidic or highly alkaline wastes. Final pH values after initial dilution can be estimated from experimental measurements or can be computed based on carbonate system alkalinity relationships.

PUBLIC WATER SUPPLY ASSESSMENT

It is possible that a public water supply (desalinization plant) intake could be contaminated by marine POTW discharges. Although such a possibility may be remote, guidance is provided in Section VI of this document to assist in this determination.

RECREATIONAL ACTIVITY ASSESSMENT

The impact of POTW discharges on recreational activities must be assessed. Recreational fisheries are considered in the biological evaluation section. Other activities such as boating, swimming, and SCUBA diving are potentially affected by microbiological contamination. For recreational impact assessment, dispersion and transport of the effluent needs to be considered in conjunction with the applicant's disinfection procedures.

BIOLOGICAL ASSESSMENT

Marine POTW discharges may affect biological communities in several ways, such as the following:

- Modified structure of benthic communities (bottom dwelling/feeding fishes and invertebrates) caused by accumulation of discharged solids on the seabed
- Stimulation of phytoplankton or macroalgal growth due to nutrient inputs
- Reductions in phytoplankton or macroalgal growth due to turbidity increases
- Reductions in dissolved oxygen due to phytoplankton blooms and subsequent die-offs leading to mass mortalities of fishes or invertebrates
- Bioaccumulation of toxic substances in marine organisms resulting from sediment contact, sediment ingestion, direct uptake from effluent, or from ingestion of contaminated organisms
- Induction of diseases in marine organisms caused by contact with contaminated sediments, by ingestion of contaminated organisms, or exposure to effluent.

Most of the potential impacts of POTW discharges are associated with the interactions of marine biota with discharged particulate matter. The potential effects of discharged solids may be compounded because many toxic substances in the effluent are adsorbed onto those suspended solids. Hence, the primary potential effects of sediment enrichment by organic particles and sediment contamination by toxic substances are closely linked and are generally manifested in the same biotic groups. There tends to be an accumulation of discharged effluent solids in the vicinity of marine discharges. Thus, bottom-dwelling marine organisms (e.g., benthic macroinvertebrates and bottom-feeding fishes) are potentially affected by these accumulations since they live in or on the sediments and are susceptible to distributional changes associated with preferences for certain bottom types, trophic modifications, and uptake of toxic substances.

Additional important environmental effects may be associated with the discharge of plant nutrients which may result in eutrophication, especially in semi-enclosed water bodies such as estuaries or coastal embayments. Related impacts can include stimulation of toxic or nuisance algal (phytoplankton) blooms. Such blooms may adversely affect commercial and recreational fisheries; the decomposition of phytoplankton after massive blooms can cause dissolved oxygen deficiencies and associated fish or invertebrate kills.

The assessment of adverse biological effects in the section 301(h) process involves assessment of whether or not a balanced indigenous population (BIP) of shellfish, fish and wildlife exists in the vicinity of the discharge and in other areas potentially affected by the discharge. Since the BIP concept forms an integral part of the applicant's biological assessment, it is important to establish the meaning and interpretation of the term in the context of a section 301(h) biological demonstration.

The term "population" does not mean a reproductive unit of a single species but rather all biological communities existing in the receiving water body. Similarly, the terms "shellfish," "fish" and "wildlife" should be intepreted to include any and all biological communities that may be affected adversely by a marine POTW discharge [40 CFR 125.58(s)].

A BIP is defined in the section 301(h) regulations [40 CFR 125.58(f)] as "an ecological community which: 1) exhibits characteristics similar to those of nearby, healthy communities existing under comparable but unpolluted environmental conditions, or 2) may reasonably be expected to become re-established in the polluted water body segment from adjacent waters if sources of pollution were removed." Balanced, indigenous populations occur in unpolluted waters. The second part of the definition concerning the re-establishment of communities is included because of its relevance to proposed, improved discharges and to discharges into waters that are stressed by sources of pollution other than the applicant's modified discharge.

The biological community characteristics that might be examined in an evaluation of a BIP include, but are not limited to: species composition, abundance, biomass, dominance, and diversity; spatial/temporal distributions; growth and reproduction of populations; disease frequency; trophic structure and productivity patterns; presence or absence of certain indicator species; bioaccumulation of toxic materials; and the occurrence of mass mortalities of fish and invertebrates.

The first step in an applicant's BIP demonstration is to define the "indigenous population" and establish the natural variablility of the "balanced population." Because EPA has determined that these are observable characteristics of natural communities existing in the absence of human disturbance, a comparative strategy is found throughout the section 301(h) regulations. Biological parameters of concern near the discharge should be compared to the range of natural variability found in comparable, but unpolluted habitats. The section 301(h) applicant is to compare biological conditions at reference (control) sites with conditions in areas of potential discharge impact within and beyond the zone of initial dilution (ZID).

Biological assessments for improved discharges, altered discharges, or discharges into stressed waters involve predictive demonstrations of future biological conditions near the outfall and elsewhere in the receiving water body. These analyses may involve establishing relationships between water quality conditions and biological conditions and using these relationships in a predictive manner. Thus, biological assessments for improved or altered discharges involve not only a description of existing biological communities but a determination of whether a BIP will exist beyond the ZID following future discharge improvements or alterations.

The concepts of spatial extent of discharge-related biological effects and intercommunity effects are important in a BIP demonstration. For example, substantial changes to one or more biological communities may be acceptable within the ZID of an open coastal discharge that would not be acceptable in other areas of potential impact outside the ZID. Such substantial changes within the ZID, however, cannot contribute to extreme adverse impacts. Observed changes in one or more communities outside the ZID may also be acceptable so long as the applicant demonstrates no resulting substantial changes to other biological communities. For example, discharge related bioaccumulation of toxics in one community may cause adverse/injurious effects on a predator community. Therefore, if differences between ZID boundary and control communities are observed, the assessment of a BIP should include a characterization of the extent and possible interrelationship(s) of effects beyond the ZID. Special emphasis should be placed upon any predicted changes in the areal extent of discharge-related effects following discharge improvements or alterations.

To support a section 301(h) modification, the applicant does not have to show that conditions of each biological community at all points beyond the ZID fall within the natural range of variation observed at the reference sites. Rather, the applicant's assessment should concentrate on determining the conditions of the following types of biological assemblages at control sites and within the area(s) of potential impact:

- Communities that are most susceptible to impacts from POTW discharges
- Communities with aesthetic, recreational, or commercial importance
- Communities with distributional patterns that enable quantitative assessment with reasonable sampling effort and resources.

Based on this approach, applicants should be able to apply available resources to study those important marine communities which would be expected to show demonstrable discharge-related effects while not expending unnecessary effort on studies with a limited potential for providing meaningful results. Based on the review of existing large section 301(h) applications, it is apparent that the major potential effects of POTW discharges are associated with benthic macroinvertebrates and demersal fishes. Because of their distribution characteristics, both of these communities can be assessed quantitatively with a reasonable level of sampling effort. Benthic macroinvertebrates are also the primary food items for demersal fishes and early-life stages of certain other fishes. Consequently, these two communities are linked by a food web relationship, and severe impacts on benthic macroinvertebrates may result in secondary impacts on demersal or other fishes.

Although, as discussed above, benthic macroinvertebrates and demersal fishes are two important groups to be assessed in making BIP demonstrations, it should not be assumed that these are the only biological communities to be studied on a case by case basis. The concept of a BIP includes any and all biological communities potentially affected by the discharge. Therefore, in addition to assessing benthic communities and demersal fishes, the applicant should consider the need to assess other discharge-related effects on other biological communities. In assessing this need, the applicant should consider the nature of the discharge (e.g., flow, location, solids emission rates, and concentrations of discharged pollutants, including toxic substances) and characteristics of the receiving water body (e.g., circulation patterns, productivity, and trophic relationships). For example, if a discharge is located close to shore or there is significant onshore transport, the assessment of effects on intertidal or subtidal macroalgae may be another important component of the BIP demonstration. Similarly, if a discharge is located in an estuary or enclosed embayment where phytoplankton blooms may be stimulated by nutrient inputs, the assessment of plankton communities may be appropriate as part of the applicant's BIP demonstration.

In determining the presence or absence of a BIP, biological differences that are detected between control sites and areas of discharge impact in this comparative approach should be evaluated in the context of adverse effects. For example, minor changes in the relative abundances of some species in a limited area may not be considered adverse. However, biological effects on a particular marine community that result in substantial secondary effects on another community, or result in a potential for adverse effects in man would normally be considered adverse. Examples of adverse impacts include, but are not limited to:

- Damage to distinctive habitats of limited distribution;
- Creation of disease epicenters in commercially or recreationally important species;
- Contamination of fishery resources by pathogenic microorganisms or their indicators;
- Mass mortalities of fish or shellfish;
- Bioaccumulation of toxic substances in fish and shellfish at levels injurous to the marine organisms or man;
- Substantially decreased abundance of commercially or recreationally important species.

The magnitude and spatial extent of observed biological effects are also important in determining whether or not biological differences between discharge impact areas and control sites would be considered as adverse. The response of biological communities to pollutant stress involves a continuum, as indicated by the gradients in biological variables near sources of organic pollutants (Pearson and Rosenberg 1978). The response of benthic invertebrates to low levels of organic enrichment may include increased abundance of some species and increased community biomass without a reduction in species richness. Such effects, although potentially outside the range of natural variability, in themselves may have little potential for causing adverse secondary effects on other biological communities. Consequently, such effects may or may not be evidence of a non-BIP. Alternatively, replacement of the natural benthic community with an assemblage dominated by pollution-tolerant organisms with different trophic/habitat characteristics may result in secondary effects on predators such as demersal fishes. Therefore, if an applicant finds evidence of changes (beyond the ZID) in a biological community that fall outside the range of natural variability, the applicant then needs to investigate other biological communities and to characterize the total extent of discharge-related changes in other potentially affected biological communities.

TOXIC SUBSTANCES ASSESSMENT

Control of toxic substances is an important element of the section 301(h) program. The discharge of toxic pollutants and pesticides can result in direct toxicity to marine organisms or result in bioaccumulation and potential detrimental effects on fishery resources and man. Emphasis is placed on control of both industrial and nonindustrial sources of toxic pollutants and pesticides. Control prior to entry into a POTW is particularly important because wastewater treatment at less than conventional secondary levels is less effective in removing toxic pollutants and pesticides in the treatment process. The toxic substances control program should therefore, be designed to identify and control toxic pollutants and pesticides at their sources.

All applicants, except those small dischargers that certify no known or suspected sources of toxic pollutants or pesticides, are to submit as part of the application chemical analyses of their effluent for all toxic pollutants and pesticides as defined in 40 CFR 125.58(u) and (m). These compounds are listed in Table VIII-1 of this document. The analyses shall be performed on two 24 hour composite samples (one dry weather and one wet weather). In addition, applicants are to identify and categorize known and suspected sources.

Applicants unable to certify no known or suspected industrial sources of toxic pollutants and pesticides are subject to industrial pretreatment program requirements. Pretreatment program development for industrial sources is to be in accordance with 40 CFR 403 regulations.

All applicants are to submit a proposed public education program designed to minimize the entrance of nonindustrial toxic pollutants and pesticides into their POTW. More substantial nonindustrial source control programs are required of all applicants, except small applicants that certify that there are no known or suspected water quality, sediment accumulation, or biological problems related to toxic pollutants or pesticides in its discharge. This program is to include a schedule of activities for identifying sources and control thereof.

MONITORING PROGRAMS

Establishment of a monitoring program for applicants granted section 301(h) modified discharge permits is important to evaluate the impact of the modified discharge on selected marine biological communities, to demonstrate continued compliance with applicable water quality standards, and to monitor effectiveness of the toxics control program.

The monitoring program consists of three parts; biological, water quality, and effluent. Although each of these parts involves sampling at different locations and for some different variables, they should not be considered as separate and independent activities, but as an integrated study. In this manner, the applicant will be able to meet specific objectives of each part of the study while also conducting a meaningful assessment of impacts of the discharge. Moreover, as predictable relationships are established among the biological, water quality, and effluent monitoring variables, it should be possible to delete certain elements of the field monitoring studies.

Biological monitoring programs normally consist of four parts: periodic surveys of biological communities, bioaccumulation determinations, sampling of sediments, and assessments of fisheries.

The continued assessment of marine biota as part of the monitoring program involves the same type of comparative strategy as is required for a BIP demonstration in the application. The characteristics of selected marine communities in the discharge vicinity are compared with biological characteristics at reference areas. Hence, a primary objective of the biological monitoring program is to evaluate continued compliance with the BIP requirements. This demonstration can be accomplished by conducting periodic (e.g., quarterly) seasonal surveys of biological communities.

Biological communities selected for study in the monitoring program should include those communities which are most likely affected by the discharge. As is the case for BIP demonstrations as part of the original application, the monitoring program should address any biological effects as to their spatial extent, magnitude, potential for secondary impacts, and potential for involvement of commercial or recreational species. All of these factors will be important in determining whether or not detectable differences in biological characteristics are adverse.

Bioaccumulation determinations and sediment sampling are used to evaluate biological effects of toxic substances in the effluent. The results of these studies may also be used to determine the need for additional (or fewer) analyses of toxic substances in indigenous organisms. Elevated or increasing levels of toxic substances in sediments or in organisms exposed to the diluted effluent would indicate the potential for adverse effects, especially if recreationally or commercially important fishery resources occurred in the outfall vicinity.

Because of the lower potential for adverse impact, small applicants are not required to propose the above elements of a biological monitoring program (except for periodic surveys of biological communities most likely to be affected by the discharge) if they meet the following requirements:

- Discharge located at a depth greater than 10 m
- Solids deposition analysis indicates negligible seabed accumulation of discharged solids near the outfall.

The water quality monitoring program is intended to evaluate compliance with applicable water quality standards and to measure the presence of toxic substances. An additional objective of the water quality monitoring program is to provide information that will supplement the biological monitoring program. This involves the collection of data that will assist in the interpretation of observed biological differences.

Monitoring of the POTW effluent is important in providing supplementary information for both the water quality and biological programs. The data are also used for demonstrating continued compliance with the modified permit effluent limitations and deciding on permit renewal applications.

III. SMALL APPLICANT QUESTIONNAIRE

I. INTRODUCTION

This questionnaire is to be used by small applicants for modification of secondary treatment requirements under section 301(h) of the Clean Water Act (CWA). A small applicant has a contributing population to its wastewater treatment facility of less than 50,000 and a projected average dry weather flow of less than 5.0 million gallons per day (MGD, 0.22 m^3/sec) [40 CFR 125.58(c)].

The questionnaire is in two sections, a general information and basic requirements section and a technical evaluation section. Satisfactory completion of this questionnaire is necessary to enable EPA to determine whether the applicant's modified discharge meets the criteria of section 301(h) and EPA regulations (40 CFR Part 125, Subpart G).

Where applicants diligently try but are unable to collect and submit all the information at the time of application, EPA requires that a plan of study for gathering and submitting the data be provided with the application. 40 CFR 125.59(f) states the procedures governing such post-application data collection activities.

Most small applicants should be able to complete the questionnaire using available information. However, small POTWs with low initial dilution discharging into shallow waters or waters with poor dispersion and transport characteristics, discharging near distinctive and susceptible biological habitats, or discharging substantial quantities of toxics should anticipate the need to collect additional information and/or conduct additional analyses to demonstrate compliance with section 301(h) criteria. Such small applicants are directed to the related sections in Parts II and III of the large applicant questionnaire and must answer the relevant questions of these sections. If there are questions in this regard, applicants should contact the appropriate EPA Regional Office for guidance.

Guidance for responding to this questionnaire is provided by the Revised Section 301(h) Technical Support Document. Where available information is incomplete and the applicant needs to collect additional data during the period it is preparing the application, EPA encourages the applicant to consult with EPA prior to data collection and submission of its application. Such consultation, particularly if the applicant provides a plan of study, will help assure that the proper data are gathered in the most efficient manner.

This chapter provides specific guidance for completing the Small Applicant Questionnaire. For this purpose, the Small Applicant Questionnaire (printed in italics) is set forth along with associated guidance (printed in conventional type). As necessary, the guidance directs some small applicants to more detailed guidance and analyses in later chapters of this document. Small POTWs with discharge or receiving water characteristics involving areas of special concern as described above should anticipate the need to collect additional information and/or conduct additional analyses to demonstrate compliance with section 301(h) criteria.

After the December 29, 1982, application deadline, collection of additional data to support an application (or application revision) must be authorized or requested by EPA and must be preceded by submittal of a plan of study to EPA [40 CFR 125.59(f)]. Additional guidance on plans of study is provided in Chapter X. Applicants submitting revised applications should refer to 40 CFR 125.59(d).

II. GENERAL INFORMATION AND BASIC DATA REQUIREMENTS

Applicants should answer all questions; where your response to a question is "yes", "no", or "not applicable," explain the basis for your response. Where your answer indicates that you cannot meet a regulatory or statutory criteria, discuss why you believe you qualify for a section 301(h) variance.

Where your response to a question is incomplete, EPA may request the collection of additional data before the application is evaluated.

A. *Treatment System Description*

1. *Are you applying for a modification based on a current discharge, improved discharge, or altered discharge as defined in 40 CFR 125.58? [40 CFR 125.59(a)]*

See Chapter II for additional descriptions of these terms.

2. *Description of the Treatment/Outfall System [40 CFR 125.61(a) and 125.61(e)]*

   a. *Provide detailed descriptions and diagrams of the treatment system and outfall configuration which you propose to satisfy the requirements of section 301(h) and 40 CFR Part 125, Subpart G. What is the total discharge design flow upon which this application is based?*
   b. *Provide a map showing the geographic location of the proposed outfall(s) (i.e., discharge). What is the latitude and longitude of the proposed outfall(s)?*
   c. *For a modification based on an improved or altered discharge, provide a description and diagram of your current treatment system and outfall configuration. Include the current outfall's latitude and longitude if different from the proposed outfall.*

Most of the above information can be found in Section 1-13 of the NPDES Standard Form A.

3. *Effluent limitations and characteristics [40 CFR 125.60(b) and 125.61(e)(2)]*

   a. *Identify the final effluent limitations for 5-day biochemical oxygen demand (BOD_5), suspended solids, and pH upon which your application for a modification is based:*

      BOD_5 _____ mg/l
      Suspended solids _____ mg/l
      pH _____ (range)

Please provide the effluent limitations you are requesting for your section 301(h) modified NPDES permit.

b. *Provide available data on the following effluent characteristics for your current discharge as well as for the modified discharge if different from the current discharge:*

Flow (m^3*/sec):*

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

BOD_5 *(mg/l) for the following plant flows:*

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Suspended Solids (mg/l) for the following plant flows:

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Toxic pollutants and pesticides (ug/l)

- *list each identified toxic pollutant and pesticide* *pH*

- *minimum*
- *maximum*

Dissolved Oxygen (mg/l prior to chlorination) for the following plant flows:

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Immediate Dissolved Oxygen Demand (mg/l)

Most of the above information can be found in plant operating records. Please indicate where requested data are not available. If you cannot certify that there are no known or suspected sources of toxic pollutants and pesticides, provide results of the chemical analyses for toxics as required by 40 CFR 125.64(a) and as discussed in Chapter VIII of this document. List all toxic substances detected including those at concentrations less than 10 ug/l.

4. *Effluent volume and mass emissions [40 CFR 125.61(e)(2) and 125.65]*

   a. *Provide analyses showing projections of effluent volume (annual average, m^3/sec) and mass loadings (mt/year) of BOD_5 and suspended solids for the design life of your treatment facility in five-year increments. If the application is based upon an improved or altered discharge, the projections must be provided with and without the proposed improvements or alterations.*

   b. *Provide projections for the end of your five-year permit term for 1) the treatment facility contributing population and 2) the average daily total discharge flow for the maximum month of the dry weather season.*

Projections may be based on expected population and service area changes over the design life of your wastewater treatment plant in five-year intervals. The projected effluent volume for Question 4.b above should be based on the maximum monthly average flow during the dry season.

5. *Average daily industrial flow (m^3/sec) (40 CFR 125.64)*

Provide or estimate the average daily industrial inflow to your treatment facility for the same time increments as in Question II.A.4.a above.

Annual average flow data will generally be sufficient for non-seasonal (i.e., continuous operation) industries. For seasonal industries, please provide average daily flows for the period(s) of operation.

6. *Combined sewer overflows [40 CFR 125.65(b)]*

   a. *Does (will) your collection and treatment system include combined sewer overflows?*
   b. *If yes, provide a description of your plan for minimizing combined sewer overflows to the receiving water.*

Please provide information on location(s), flow quantity(ies), and frequency of overflows along with a narrative description and schedule of your plan for minimizing the discharge of combined sewer overflows to the receiving waters.

7. *Outfall/diffuser design. Provide available data on the following for your current discharge as well as for the modified discharge, if different from the current discharge: [40 CFR 125.61(a)(1)]*

   - *diameter and length of the outfall(s) (meters)*
   - *diameter and length of the diffuser(s) (meters)*
   - *angle(s) of port orientation(s) from horizontal (degrees)*
   - *port diameter(s) (meters)*

- *orifice contraction coefficient(s), if known*
- *vertical distance from mean lower low water (or mean low water) surface and outfall port(s) centerline (meters)*
- *number of ports*
- *port spacing (meters)*
- *design flow rate for each port, if multiple ports are used (m^3/sec).*

The above data should be available from the engineering drawings for your treatment plant outfall/diffuser system. Please indicate in your response where requested data are not available.

B. *Receiving Water Description*

1. *Are you applying for a modification based on a discharge to the ocean or to a saline estuary [40 CFR 125.58(q)]? [40 CFR 125.59(a)]*

"Ocean waters" are defined in 40 CFR 125.58(1) and are those coastal waters landward of the baseline of the territorial seas, the deep waters of the territorial seas, or the waters of the contiguous zone. Territorial seas extend 3 miles outward from the baseline and the contiguous zone extends an additional 9 miles.

"Saline estuarine waters" are defined in 40 CFR 125.58(q) and are those semi-enclosed coastal waters which have a free connection to the territorial sea, undergo net seaward exchange with ocean waters, and have salinities comparable to those of the ocean. Generally, these waters are near the mouths of estuaries and have cross-sectional, annual mean salinities greater than 25 parts per thousand. It should be noted, however, that 25 ppt is used as a general test in section 125.58(q) and the failure of the receiving water to meet this salinity concentration does not absolutely preclude eligibility for consideration under section 301(h). However, where salinities fall significantly below this concentration, applicants should be careful to document that the waters into which they discharge meet the other requirements of section 125.58(q) (i.e., free connection to the territorial sea and net seaward exchange with ocean waters).

2. *Is your current discharge or modified discharge to stressed waters? If yes, what are the pollution sources contributing to the stress? [40 CFR 125.61(f)]*

"Stressed waters" are defined in 40 CFR 125.58 (t) and are receiving water environments in which a balanced indigenous population (BIP) does not exist as a result of factors other than the applicant's modified discharge. If an applicant's discharge is to stressed waters, the application must demonstrate that the modified discharge will not contribute to the stress or retard recovery if other pollutant sources are diminished and/or removed.

Please state the basis for your conclusion if your answer to this question is no. Please provide a list of the locations and descriptions of other point and nonpoint sources that may be contributing to the stress if your answer is yes.

3. *Provide a description and available data on the seasonal circulation patterns in the vicinity of your current and modified discharge(s). [40 CFR 125.61(a)]*

Information on current speed and direction in the vicinity of the discharge is needed to describe dispersion and transport of the diluted effluent. U.S. Department of Commerce (U.S. DOC 1979a, b) tidal current prediction tables are a useful source for this information.

4. *Ambient water quality conditions during the period(s) of maximum stratification.*

   a. *Provide available data on the following in the vicinity of the current discharge location and for the modified discharge location if different from the current discharge: [40 CFR 125.60(b)(1)]*

      - *Dissolved oxygen (mg/l)*
      - *Suspended solids (mg/l)*
      - *pH*
      - *Temperature (^{o}C)*

- *Salinity (ppt)*
- *Transparency (turbidity, percent light transmittance)*
- *Other significant variables (e.g., nutrients, toxic pollutants and pesticides, fecal coliform).*

Please provide the available water quality data from areas outside the impact area of the discharge but close enough to be representative of water quality conditions in the absence of the discharge. The dissolved oxygen, suspended solids, pH, and transparency data are needed for assessing compliance with water quality standards. The temperature and salinity data are needed for determining densities used in the initial dilution calculations and for determining whether the discharge is to a saline estuary. The applicant should assess the need for submitting data on other variables which will help to understand water quality conditions in the vicinity of the discharge. Sources of information on ambient conditions are discussed in Chapter VI of this document.

b. *Are there other periods when receiving water quality conditions may be more critical than the period(s) of maximum stratification? If so, describe these other critical periods and provide the data requested in 4.a for the other critical periods. [40 CFR 125.61(a)(1)]*

Other periods of concern include periods of exceptional biological activity; periods of maximum hydraulic loading, periods of low background water quality; periods of low net circulation, periods of low effective net flushing or low intertidal mixing, and periods of minimum stratification.

C. *Biological Conditions*

1. a. *Are distinctive habitats of limited distribution (such as kelp beds or coral reefs) located in areas potentially affected by the modified discharge? [40 CFR 125.61(c)]*
   b. *If yes, provide available information on types, extent, and location of habitats.*

Available information should be used by the applicant to describe all distinctive habitats of limited distribution identified in the vicinity of the outfall and in other areas potentially influenced by the discharge. Distinctive habitats of limited distribution include those marine environments whose protection is of special concern because of their ecological significance or value to man. These habitats include, but are not limited to, coral reefs, kelp beds, seagrass meadows, intertidal or subtidal rock outcroppings, sites of productive fisheries and all areas recognized as marine or estuarine sanctuaries.

The basic information supplied by the applicant is expected to be descriptive in nature and should not require field sampling. Possible sources of information on distinctive habitats include:

- Contacts with local offices of state conservation agencies
- Review of literature, especially resource maps available for many areas.

Since most distinctive habitats are visible to a surface observer, the applicant may also use direct visual observation of the marine environment in the outfall vicinity. If such habitats are not present in areas potentially affected by the applicant's discharge, the applicant must document the source(s) of this information. If distinctive habitats are present in the potentially affected area(s), the applicant must provide available information, or estimate, the types, location and extent of such habitats. Potential impacts of the discharge should be assessed in the response to Question III.D.2.

2. a. *Are commercial or recreational fisheries located in areas potentially affected by the modified discharge? [40 CFR 125.61(c)]*

   b. *If yes, provide available information on types, location and value of fisheries.*

Documentation of fisheries in the receiving water body is important because of economic and recreational aspects and because of the potential for human consumption of contaminated organisms. The applicant should use available information to describe commercial or recreational fishery resources in the receiving water body. Potentially important resources include molluscan (e.g., clams), epibenthic crustacean (e.g., crabs), demersal (e.g., flounder) and pelagic (e.g., salmon) fisheries.

Applicants should consider contacting the following information sources to determine if fishing resources occur in the outfall vicinity and to collect descriptive information:

- Local fishermen
- Public, institutional or agency libraries
- Academic institutions
- Local, state or federal resource agencies
- Regional fishery management councils
- State and federal public health agencies.

If commercial or recreational fishery resources are not present in areas potentially affected by the applicant's discharge, the applicant should document the source(s) of this conclusion. Affidavits or reports of personal contacts from fishery biologists, marine ecologists, oceanographers, or other experts that have studied fishery resources in your general area will normally provide sufficient support to such a conclusion. If fisheries are present, the applicant should provide available information on the type, location, and value of the fisheries. Potential impacts of the modified discharge should be assessed in response to Question III.D.3.

D. State and Federal Laws [40 CFR 125.60]

1. Are there water quality standards applicable to the following pollutants for which a modification is requested:

- *Biochemical oxygen demand or dissolved oxygen?*
- *Suspended solids, turbidity, light transmission, light scattering, or maintenance of the euphotic zone?*
- *pH of the receiving water?*

2. *If yes, what is the water use classification for your discharge area? What are the applicable standards for your discharge area for each of the parameters for which a modification is requested? Provide a copy of all applicable water quality standards or a citation to where they can be found.*

3. *Will the modified discharge [40 CFR 125.59(b)(3)]:*

   - *Be consistent with applicable State coastal zone management program(s) approved under the Coastal Zone Management Act as amended, 16 U.S.C. 1451 et seq.? [See 16 U.S.C. 1456(c)(3)(A)]*

   - *Be located in a marine sanctuary designated under Title III of the Marine Protection, Research, and Sanctuaries Act (MPRSA) as amended, 16 U.S.C. 1431 et seq. or in an estuarine sanctuary designated under the Coastal Zone Management Act as amended, 16 U.S.C. 1461? If located in a marine sanctuary designated under Title III of the MPRSA, attach a copy of any certification or permit required under regulations governing such marine sanctuary [See 16 U.S.C. 1432(f)(2)]*

   - *Be consistent with the Endangered Species Act as amended, 16 U.S.C. 1531 et seq.? Provide the names of any threatened or endangered species that inhabit or obtain nutrients from waters that may be affected by the modified discharge. Identify any critical habitats that may be affected by the modified discharge and evaluate whether the modified discharge will affect threatened or endangered species or modify a critical habitat [See 16 U.S.C. 1536(a)(2)]*

4. *Are you aware of any State or Federal Laws or regulations (other than the Clean Water Act or the three statutes*

identified in item 3 above) or an Executive Order which is applicable to your discharge? If yes, provide sufficient information to demonstrate that your modified discharge will comply with such law(s), regulations(s), or order(s). [40 CFR 125.59(b)(3)]

Applicants should contact the state water quality agency for answers to D.1 and D.2 and the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and state coastal zone management agency for a response to D.3. A list of state water quality agencies, coastal zone management agencies, and regional offices of the NMFS, USFWS, and EPA is provided as Appendix A to this document.

III. TECHNICAL EVALUATION

Answers to the following questions will be used to assess the effects of the modified discharge. The responses will be used by the State agency(s) in their determination [as required by 40 CFR 125.60(b)(2) and 125.63(b)] and by EPA in preparing its decision on the applicant's request for a section 301(h) variance.

Your answers to the following questions must be supported by data and responses from Section II of this questionnaire. The analyses and calculations required below must show the input [supporting] *data for all calculations. Applicants should answer all questions; where your answer to a question is "yes", "no", or "not applicable," explain the basis for your response. Where your answer indicates that you cannot meet a regulatory or statutory criterion, discuss why you believe you qualify for a variance.*

If EPA decides to check calculations in an application, the formulas and methods provided in this document may be used for that purpose. If applicants use methods other than those provided in this document, such methods must be described by the applicant.

A. Physical Characteristics of Discharge [40 CFR 125.61(a)]

1. *What is the lowest initial dilution for your current and modified discharge(s) during 1) the period(s) of maximum*

stratification? and 2) any other critical period(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?

The dilution achieved by the effluent plume is an important factor in assessing the likelihood of water quality standards violations. There are a number of methods available to compute initial dilution. Small dischargers may use one of the two simplified methods (A and B) described in this section or one of the more complex methods contained in Chapter V of this document. The simpler of the two, Method A, will usually produce lower initial dilution estimates and both methods will usually produce estimates lower than those obtained with one of the mathematical models described in Chapter V. These simplified methods have been provided in this document for small applicants with limited receiving water data and limited resources who are unable to use the more complex mathematical models.

These simplified methods require calculation of the diffuser Froude number and estimation of the discharge plume's height of rise. With these two numbers and the flow rate through a single diffuser port the applicant can estimate initial dilution, (S_a).

The two methods presented in this section are based upon results obtained using the EPA dilution model PLUME (Teeter and Baumgartner 1979) with the following simplifying assumptions:

- The effluent is discharged horizontally
- The effluent density is 1.000 g/cc
- The bottom receiving water density is 1.025 g/cc (density of standard seawater)
- The receiving water density gradients are constant from the bottom to the surface and are within the range of 1×10^{-5} to 1×10^{-2} g/cc/m.

If the applicant's discharge deviates significantly from these assumptions, the procedures contained in Chapter V of this document should be followed.

In addition, in developing Method A, it is assumed that a small discharge will produce a plume whose relative height of rise is less than the minimum relative heights of rise calculated for 90 percent of the first 30 section 301(h) applications reviewed (where the relative height of rise is the height of rise divided by the total water depth). Method B assumes that the plume continues to entrain bottom water until the plume density equals the ambient surface density. If the height of rise required to achieve this density is greater than the water depth, then it is assumed that the plume surfaces.

The equations used in the methods presented here require values in metric units, for example, flow in cubic meters per second (m^3/sec) and linear units in meters (m). A list of the variables used in these equations and formulas for converting from English to metric units are provided here:

Variables:

H = water depth at the discharge, m
Q = total effluent discharge flow, m^3/sec
d = discharge port diameter, m
n = number of discharge ports
T_B = temperature of near-bottom receiving water, ^oC
S_B = salinity of near-bottom receiving water, ppt
T_S = temperature of surface receiving water, ^oC
S_S = salinity of surface receiving water, ppt

Conversion Formulas:

meter = feet/3.281
m^3/sec = MGD/22.82
$^oC = (^oF - 32) \times 5/9$.

The steps which may be followed in estimating initial dilution for small discharges are:

Step 1. Calculate flow rate per port, q(m^3/sec)

$$q = \frac{\text{total flow } (m^3/\text{sec})}{n \text{ (number of ports)}}$$

Step 2. Calculate

$$K = q/\sqrt{d^5}$$

where:

K = a variable calculated to facilitate the determination of the Froude number but does not represent a specific physical process or quantity
q = flow rate per port, m^3/sec
d = port diameter, m.

Step 3. Estimate bottom receiving water density, σ_B, from Table III-1.

Step 4. Compute the Froude number

$$Fr = (K)\,\frac{12.855}{\sqrt{\sigma_B}}$$

Step 5. Calculate initial dilution by either Method A or Method B or by both methods. A consideration in selecting either Method A or B is the level of knowledge concerning the receiving water. Method A requires that a near-bottom salinity and temperature be available or estimated (Step 3, above) for the period of maximum stratification. Method B, however, requires both near-bottom and surface salinity and temperature for the critical period. These data may be available from studies previously performed near the outfall or the applicant may elect to determine these values. In either event, the date and time of the salinity and temperature observations should be stated. Other considerations are that Method A is the easier of the two methods to apply and, in general, provides a lower (more conservative) initial dilution estimate.

TABLE III-1. SEAWATER DENSITIES (EXPRESSED IN σ_t UNITS) FOR SELECTED TEMPERATURES AND SALINITIES[1]

T (DEG C)	SALINTIY (PPT) 25	26	27	28	29	30	31	32	33	34	35
0	20.085	20.888	21.692	22.496	23.300	24.104	24.908	25.713	26.518	27.324	28.130
2	20.012	20.810	21.607	22.405	23.202	24.001	24.799	25.598	26.397	27.196	27.996
4	19.884	20.676	21.467	22.259	23.051	23.843	24.636	25.429	26.223	27.016	27.811
6	19.704	20.490	21.276	22.063	22.849	23.636	24.423	25.211	25.999	26.788	27.577
8	19.475	20.256	21.037	21.818	22.599	23.381	24.163	24.946	25.729	26.513	27.297
10	19.199	19.975	20.751	21.528	22.305	23.082	23.859	24.637	25.416	26.195	26.974
12	18.880	19.651	20.423	21.195	21.967	22.740	23.513	24.287	25.061	25.836	26.611
14	18.518	19.285	20.053	20.821	21.589	22.358	23.127	23.897	24.667	25.437	26.208
16	18.116	18.880	19.643	20.408	21.172	21.937	22.702	23.468	24.235	25.001	25.769
18	17.676	18.436	19.196	19.957	20.718	21.479	22.241	23.003	23.766	24.530	25.294
20	17.198	17.955	18.712	19.469	20.227	20.985	21.744	22.503	23.263	24.023	24.784
22	16.684	17.438	18.192	18.946	19.701	20.456	21.212	21.968	22.725	23.483	24.241
24	16.135	16.886	17.637	18.389	19.141	19.894	20.647	21.401	22.155	22.910	23.665
26	15.552	16.300	17.049	17.798	18.548	19.298	20.049	20.800	21.552	22.304	23.058
28	14.935	15.681	16.428	17.175	17.922	18.670	19.419	20.168	20.917	21.668	22.419
30	14.285	15.029	15.773	16.518	17.264	18.010	18.757	19.504	20.252	21.000	21.749

1 σ_t Unit = (density (g /cc) - 1) x 1,000.

Reference: Teeter and Baumgartner (1979)

Example: Salinity = 32.5 ppt, temperature = 12.8°C

$$\text{Sigma}_t\ (32.5,\ 12.0) = (25.061 - 24.287)\ \frac{(32.5 - 32.0)}{(33.0 - 32.0)} + 24.287 = 24.674$$

$$\text{Sigma}_t\ (32.5,\ 14.0) = (24.667 - 23.897)\ \frac{(32.5 - 32.0)}{(33.0 - 32.0)} + 23.897 = 24.282$$

$$\text{Sigma}_t\ (32.5,\ 12.8) = (24.282 - 24.674)\ \frac{(12.8 - 12.0)}{(14.0 - 12.0)} + 24.674 = 24.517$$

Method A:

A1. Compute the minimum plume height of rise, Hr, for discharge water depths less than or equal to 19 m,

$$Hr = 0.2H$$

or, for discharge water depths greater than or equal to 19 m.

$$Hr = 0.25\ (H-19) + 3.8$$

A2. Compute B, which is a variable calculated to facilitate the estimation of initial dilution, but does not represent a specific physical process or quantity

$$B = Hr/q^{0.4}$$

A3. Determine initial dilution, S_a, by entering Figures III-1 or III-2 with the values B and F_r. The intersection point of these two values provides the initial dilution estimate which can be interpolated between the lines of equal dilution.

Method B:

B1. Using the available ambient surface and bottom salinity-temperature measurement pairs, find the pair having the highest density (using Table III-1). Let σ_B and σ_S be the bottom and surface densities of this pair. If temperature and salinity measurements exist in published documents which are appropriate for the applicant's outfall location, these may be used.

B2. Compute

$$S = \sigma_B/(\sigma_B - \sigma_S)$$

where S is the dilution which would occur if, at the maximum height of rise, the plume density equals the ambient surface density.

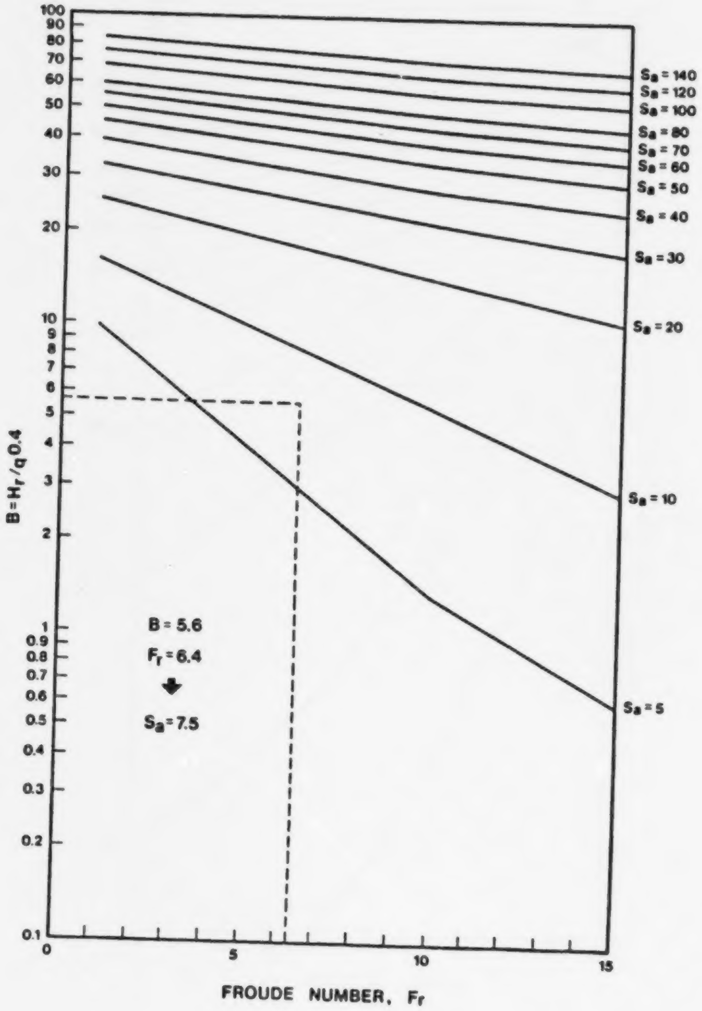


Figure III-1. Small discharger initial dilution relationships, F_r = 1 to 15.

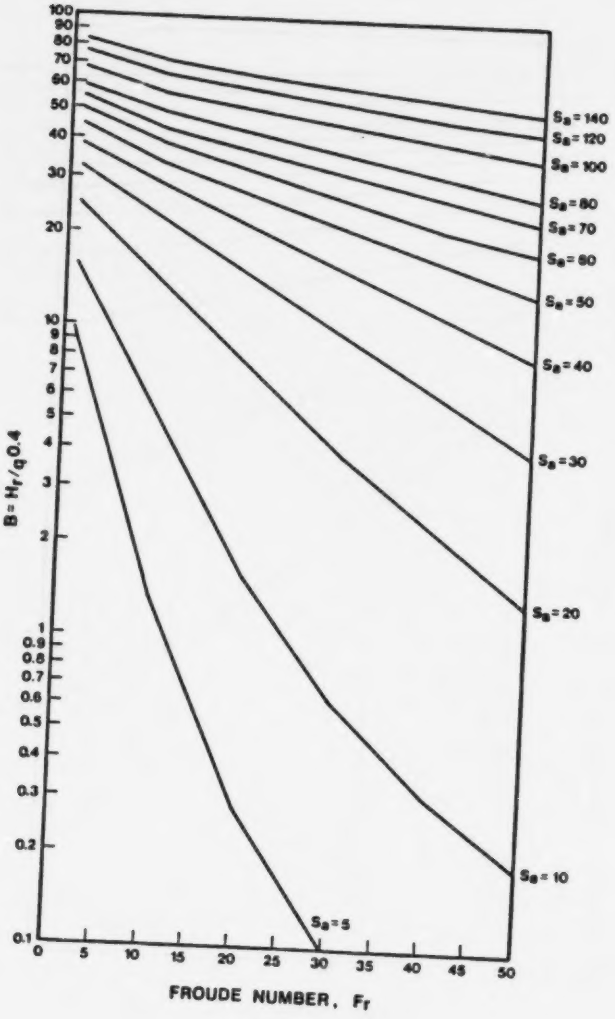


Figure III-2. Small discharger initial dilution relationships, F_r = 1 to 50.

B3. Enter Figure III-1 or Figure III-2 with the Froude number and, using S as an initial estimate of S_a, estimate the corresponding value of B.

B4. Calculate the height of rise using the value of B estimated in B3 above with the equation

$$Hr = Bq^{0.4}$$

B5. If the height of rise, Hr, is less than the water depth, H, then S is the initial dilution S_a. If Hr is greater than H, set Hr equal to H, and calculate a value of B (using the equation in Step A.2 above) which is used with F_r to obtain a new S_a value from Figures III-1 and III-2.

A worked example is provided in this section to illustrate the estimating procedures for initial dilution.

Example:

H = water depth = 20 ft (6.1 m)
Q = total effluent flow = 0.5 MGD (0.0219 m^3/sec)
d = port diameter = 6 in (0.152 m)
n = number of ports = 1
T_B = bottom temperature = 60^o F (15.56^o C)
S_B = bottom salinity = 32.5 ppt
$_S$ = surface temperature = 62^o F (16.67^o C)
S_S = surface salinity - 32.5 ppt

Step 1.

$$q = \frac{0.0219}{1} = 0.0219 \text{ m}^3/\text{sec}$$

Step 2.

$$K = \frac{0.0219}{\sqrt{(0.152)^5}} = 2.43$$

Step 3.

$$\sigma_B = 23.95$$

Step 4. $$Fr = 2.43 \times \frac{12.855}{\sqrt{23.95}} = 6.38$$

Step 5. Calculation of initial dilution by Method A or Method B.

Method A:

A1. H = 6.1 m which is less than 19 m, therefore use Hr = 0.2H

$$Hr = 0.2 \times 6.1 = 1.22 \text{ m}$$

A2. $$B = \frac{1.22}{(0.0219)^{0.4}} = 5.63$$

A3. S_a = 7.5, say 8, from Figure III-1.

Or, alternatively, Method B could be used as follows:

Method B:

B1. From Table III-1

$$\sigma_B = 23.95$$

$$\sigma_S = 23.70$$

B2. $$S = \frac{23.95}{23.95 - 23.70}$$

$$S = 95.8, \text{ say } 96$$

B3. From Figure III-1 for F_r = 6.38 and S = 96;

$$B = 59.7$$

B4. $Hr = 59.7 \times (0.0219)^{0.4} = 12.95$ m

B5. Since Hr is greater than H, set Hr = 6.1 m and

$$B = 6.1/(0.0219)^{0.4} = 28.1\text{, say } 28$$

from Figure III-1, $S_a = 32.9$.

For comparison, the EPA model PLUME, run for the conditions of this example, produces an initial dilution value, S_a, of 40.4. The relative trend of the results obtained by the different methods for this example is indicative of the general condition. Generally, method A provides lower estimates than method B, and methods A and B provide lower estimates than the mathematical models described in Chapter V.

2. *What are the dimensions of the zone of initial dilution for your modified discharge(s)?*

The ZID may be considered as the bottom area within a distance equal to the water depth from any point on the diffuser and the water column above that area. Alternative methods for calculating ZID dimensions may be used but the ZID may not be larger than mixing zone restrictions in applicable water quality standards. The applicant is encouraged to consult with the state water quality agency on an appropriate method for ZID calculations.

3. *Will there be significant sedimentation of suspended solids in the vicinity of the modified discharge?*

A simplified approach to determining the need for detailed analysis of suspended solids accumulation has been developed to aid small dischargers that are not likely to have sediment accumulation related problems. Two types of problems (dissolved oxygen depletion and biological effects) and two types of receiving water environment (open coastal and semi-enclosed bays or estuaries) have been considered.

Figure III-3 is to be used for open coastal areas that are generally considered "well flushed." The dashed line represents combinations of solids mass emission rates and plume heights of rise that would result in a steady-state sediment accumulation of 50 g/m^2. Review of data from several open coast discharges has indicated that biological effects are minimal when accumulation rates were estimated to be below this level. Consequently, if the applicant's mass emission rate and height of rise fall below this line

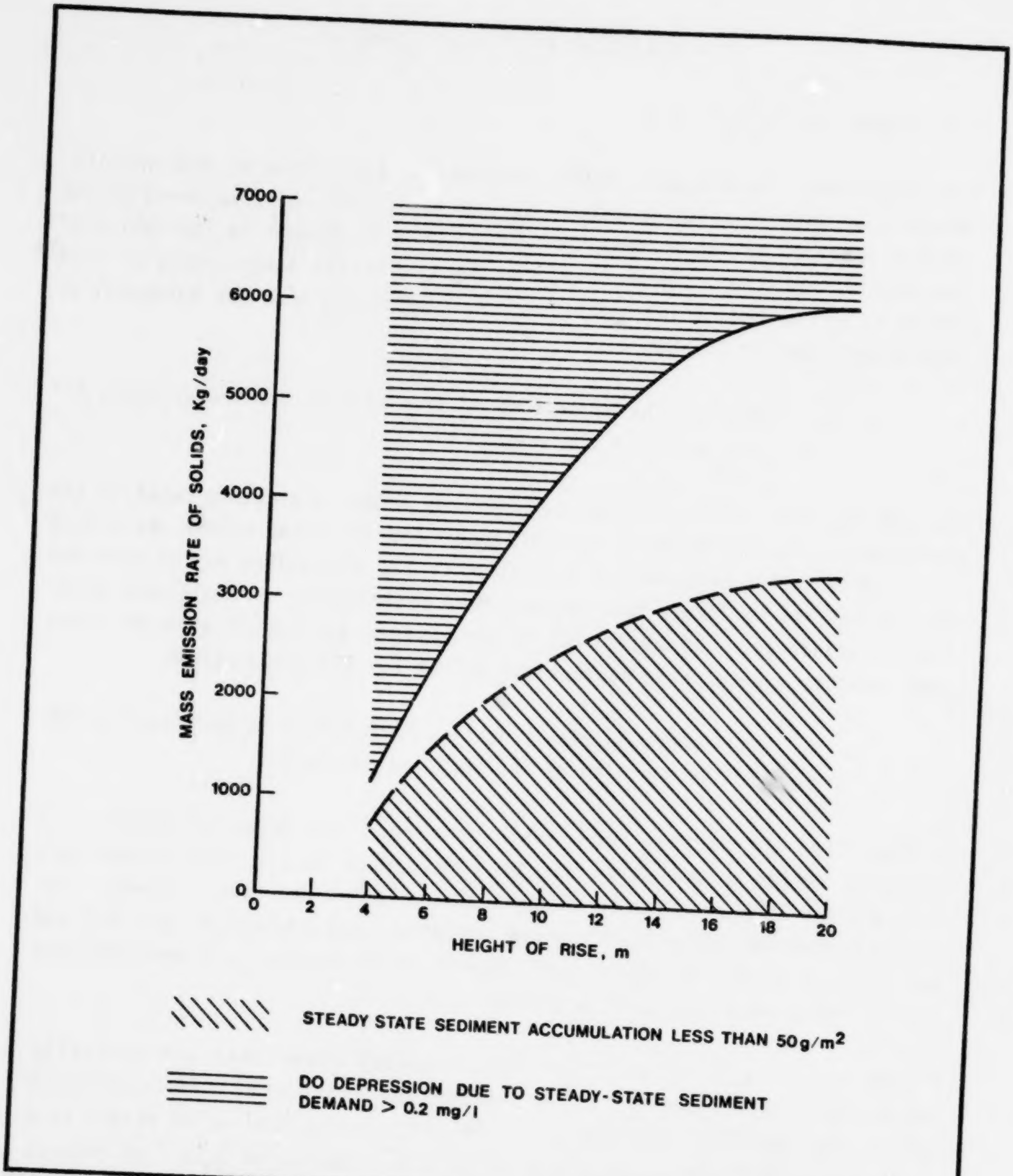


Figure III-3. Projected relationships between suspended solids mass emission, plume height of rise, sediment accumulation and dissolved oxygen depression for open coastal areas.

no further sediment accumulation analyses are needed. Applicants whose discharge characteristics fall above the line should conduct a more detailed analysis of sediment accumulation and biological effects as discussed in the biological impact section (VI-7) and (II.D.1), respectively.

The solid line in Figure III-3 represents a combination of mass emission rates and plume heights of rise which were projected to result in sufficient sediment accumulation to cause a 0.2 mg/l oxygen depression. Applicants whose discharge falls below this line need not provide any further analysis of sediment accumulation as it relates to dissolved oxygen.

Figure III-4 should be used in a similar manner for discharges to semi-enclosed embayments or estuaries. Because estuaries and semi-enclosed embayments are potentially more sensitive than open coastal areas, the critical sediment accumulation was set at 25 g/m^2.

The methods described in Chapter VI of this document were used to determine the mass emission rates and heights of rise resulting in the sediment accumulation rates specified above. In order to use these methods several assumptions were made. The estimated variables include ambient current velocity and a settling velocity distribution. The current velocities used were 5 cm/sec for the open coastal sites and 2.5 cm/sec for the semi-enclosed embayment case. These velocities are conservative estimates of average currents velocities over a 1 year period. The settling velocity distribution used is considered typical of primary or advanced primary effluents and is shown below:

5 percent have $V_s \geq 0.1$ cm/sec
20 percent have $V_s \geq 0.01$ cm/sec
30 percent have $V_s \geq 0.006$ cm/sec
50 percent have $V_s \geq 0.001$ cm/sec

The remaining solids settle so slowly that they are assumed to remain suspended in the water column indefinitely. The effluent is considered to be 80 percent organic and 20 percent inorganic. The above distribution is based on the review of data in section 301(h) applications and other published data (Herring and Abati 1978; Myers 1974).

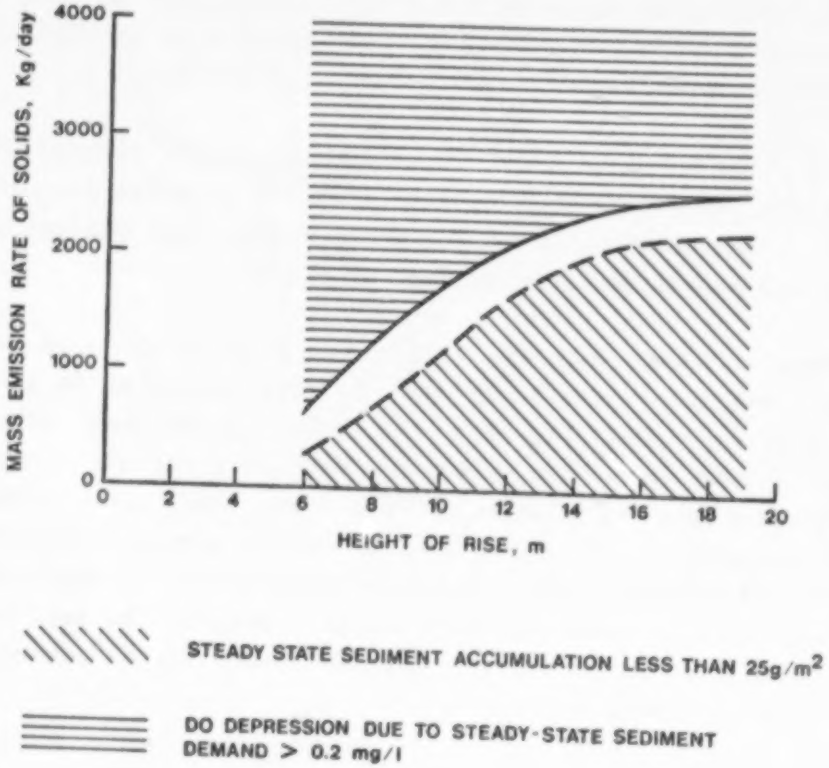


Figure III-4. Projected relationships between suspended solids mass emission, plume height of rise, sediment accumulation and dissolved oxygen depression for semi-enclosed embayments and estuaries.

The applicant is to calculate the annual suspended solids mass emission rate (MER) using the average flow rate and an average suspended solids concentration. The plume height of rise, Hr, determined previously in the initial dilution calculation, or 0.6 times the water depth, whichever is larger, should be used to enter the appropriate figure.

B. *Compliance with Applicable Water Quality Standards [40 CFR 125.60(b) and 125.61(a)]*

1. *What is the concentration of dissolved oxygen immediately following initial dilution for the period(s) of maximum stratification and any other critical period(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?*

Dissolved oxygen immediately following initial dilution depends on the level of dissolved oxygen in the discharge, the immediate dissolved oxygen demand of the discharge, the receiving water dissolved oxygen concentration, and the initial dilution. Detailed methods and data requirements to compute dissolved oxygen concentrations are provided in Chapter VI of this document. However, for small discharges, an estimate of the dissolved oxygen depression can be obtained from Table III-2. Table III-2 gives estimated dissolved oxygen depressions for initial dilutions ranging from 10 to 100 and for untreated (raw) sewage discharges, primary effluents, and advanced primary effluents. If the estimated dissolved oxygen depression is considered to be small relative to applicable water quality standards and receiving water concentrations, no further analysis is needed. If depressions are substantial (e.g., greater than 0.5 mg/l or the applicable water quality standard is violated), a more refined analysis as described in Chapter VI is necessary.

2. *What is the farfield dissolved oxygen depression and resulting concentration due to BOD exertion of the wastefield during the period(s) of maximum stratification and any other critical period(s)?*

Following initial dilution, the wastefield is dispersed and BOD of the wastefield is exerted. These two processes result in a balance between

TABLE III-2. ESTIMATED DISSOLVED OXYGEN DEPRESSION FOLLOWING INITIAL DILUTION

Initial Dilution	Level of Treatment		
	Untreated (Raw)[a]	Primary[b]	Advanced Primary[c]
10	1.00-1.20	0.70-0.90	0.50-0.70
20	0.50-0.60	0.35-0.45	0.25-0.25
30	0.33-0.40	0.23-0.30	0.17-0.23
40	0.25-0.30	0.18-0.22	0.13-0.18
50	0.20-0.24	0.14-0.18	0.10-0.14
60	0.16-0.20	0.12-0.15	0.18-0.12
70	0.21-0.17	0.10-0.13	0.07-0.10
80	0.13-0.15	0.09-0.11	0.06-0.09
90	0.11-0.13	0.08-0.10	0.06-0.08
100	0.10-0.12	0.07-0.09	0.05-0.07

Note: Effluent dissolved oxygen concentration = 0.0 for all cases. The range is due to the difference between using an ambient dissolved oxygen of 5 or 7 mg/l.

[a] Effluent BOD_5 concentrations of untreated sewage were considered to be 150 mg/l or greater and the IDOD was estimated as 5 mg/l.

[b] Effluent BOD_5 concentrations of primary plants were considered to be 50 to 150 mg/l and the IDOD was estimated as 2 mg/l.

[c] Effluent BOD_5 concentrations of advanced primary plants were considered to be 50 mg/l or less and an IDOD of 0.0 mg/l was used.

mixing and BOD exertion which can result in dissolved oxygen depressions. An estimate of the farfield dissolved oxygen depression can be obtained by using the following simple formula.

$\Delta DO = BOD_5/30(S_a)$ for areas which are well mixed, open coastal areas.

and

$\Delta DO = BOD_5/10(S_a)$ for areas which are poorly mixed, semi-enclosed embayments.

where:

ΔDO = farfield oxygen depression, mg/l
BOD_5 = 5 day BOD concentration in the effluent, mg/l
S_a = initial dilution.

The constants in the above equation are conservative estimates of subsequent dilution in the given water body. Total dilution is the initial dilution times the subsequent dilution. More refined methods for estimating subsequent dilution for a specific site are given in Chapter VI of this document.

If the estimated farfield oxygen depression is small (less than 0.2 mg/l) and within applicable water quality standards, and receiving water concentrations are predicted to meet applicable standards, no further analysis is needed. If these calculations indicate that water quality standards would not be met by the applicant, a more refined analysis as described in Chapter VI may be appropriate.

3. *What is the increase in receiving water suspended solids concentration immediately following initial dilution of the modified discharge(s)?*

Suspended solids in the effluent can result in reduced light transmittance, a visible plume, and deposition of solids. The change in concentration following initial dilution should be estimated using the following formula:

$$\Delta SS = SS_e/S_a$$

where:

ΔSS = increase in suspended solids, mg/l
SS_e = suspended solids concentration in the effluent, mg/l
S_a = initial dilution.

4. *Does (will) the modified discharge comply with applicable water quality standards for:*

   - *Dissolved oxygen?*
   - *Suspended solids or surrogate standards?*
   - *pH*

The applicant can compare his answers to B.1 and B.2 above to the applicable water quality standards (provided in response to II.D.1 above) for determining compliance with the dissolved oxygen standard. Most states, however, provide only surrogate standards for suspended solids such as Secchi disc depths and light transmittance. Consequently, the applicant may need to consult with water quality agency officials for a determination of whether the calculated increase in suspended solids (B.3 above) is significant. For pH, it is expected that very few small marine dischargers will have a problem complying with applicable water quality standards. Unless the effluent pH values fall outside the range of applicable standards, no problems should be anticipated. If effluent pH values do fall outside the limits, the applicant should consult Chapter VI for more detailed guidance.

5. *Provide the determination required by 40 CFR 125.60(b)(2) or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.*

C. *Impact on Public Water Supplies [40 CFR 125.61(b)]*

1. *Is there a planned or existing public water supply (desalinization facility) intake in the vicinity of the current or modified discharge?*

2. *If yes,*

   a. *what is the location of the intake(s) (latitude and longitude)?*
   b. *will the modified discharge(s) prevent use of the intake(s) for public water supply?*
   c. *will the modified discharge(s) cause increased treatment requirements for the public water supply(s) to meet local, State, and EPA drinking water standards?*

It is not expected that any marine POTW discharges will affect public water supply intakes. At the present time in the United States, there are only a few desalinization plants designed to provide potable water and most of these are used for research purposes. Table III-3 lists desalinization plants identified through the section 301(h) review process. The applicant should also contact state water quality agencies, public health departments, any local military facilities, and local water supply departments to determine if any plants exist or are planned in the vicinity of the applicant's discharge. If no desalinization plants or other water supply intakes exist within 16 km (10 mi) of the discharge, no analyses are required. The name of the agencies contacted and the person involved should be listed in the application.

If a water supply intake does exist, the location should be shown on a map with the discharge site marked. The travel time to the intake should be estimated using the average current speed. The applicant should show that all water quality standards are met at the intake using the methods discussed in this document.

D. *Biological Impact of Discharge [40 CFR 125.61(c)]*

1. *Does (will) a balanced indigenous population of shellfish, fish, and wildlife exist:*

TABLE III-3. KNOWN DESALINIZATION PLANTS

Plant Location	Status	Purpose
Rosarito, Mexico	operating	water supply
California-American Water Company at San Diego Bay, CA	closed	water supply
Virginia Beach, VA	proposed	water supply
Santa Catalina Island, CA	operating	water supply

a. *immediately beyond the ZID of the current and modified discharge(s)?*

b. *in all other areas beyond the ZID where marine life is actually or potentially affected by the current and modified discharge(s)?*

The applicant should use available information on the biological communities near its discharge, or from comparable discharges, to describe any existing or predicted effects. Small applicants may be able to provide evidence of the absence of adverse biological effects (i.e., the presence of a BIP) without conducting field studies if certain outfall and receiving water characteristics indicate a very low potential for impact. These characteristics include:

- Outfall located at water depths greater than 10 m (33 ft)
- Hydrographic regimes resulting in low predicted solids accumulation rates
- Absence of distinctive habitats of limited distribution and absence of fisheries in the outfall vicinity
- Absence of known or suspected sources of toxic pollutants and pesticides and/or low concentrations of these substances in the effluent.

If the applicant's assessment of available information indicates the need for additional analyses and/or data collection, Chapters VII and X should be consulted for more detailed guidance.

2. *Have distinctive habitats of limited distribution been impacted adversely by the current discharge and will such habitats be impacted adversely by the modified discharge?*

If distinctive habitats are present in areas potentially affected by the discharge, Chapter VII should be consulted for more detailed guidance. The applicant should use information on effluent dispersion patterns, historical occurrence of the habitat, or present status of the habitat to determine or predict effects of the modified discharge. The emphasis of the applicant's response should include the potential for effluent transport to the distinctive habitat. If field studies are necessary to document existing conditions of distinctive habitats located in areas potentially influenced by the effluent, the applicant should also consult Chapter X.

3. *Have commercial or recreational fisheries been impacted adversely (e.g., warnings, restrictions, closures, or mass mortalities) by the current discharge and will they be impacted adversely by the modified discharge?*

If fishery resources are present in areas potentially influenced by the discharge, Chapter VII should be consulted for more detailed guidance. The applicant should use information on effluent dispersion patterns and historical status of the fisheries to determine if impacts on fisheries have occurred. Information on fishery closures/warnings, contamination, diseases, or catch reductions should be used to evaluate effects. The emphasis of the applicant's response should include the potential for effluent transport to the fishery areas, the potential for sediment accumulation in those areas, and the concentration of toxic substances in the effluent.

4. *For discharges into saline estuarine waters: [40 CFR 125.61(c)(4)]*

    a. *does or will the current or modified discharge cause substantial differences in the benthic population within the ZID and beyond the ZID?*
    b. *does or will the current or modified discharge interfere with migratory pathways within the ZID?*
    c. *does or will the current or modified discharge result in bioaccumulation of toxic pollutants or pesticides at levels which exert adverse effects on the biota within the ZID?*

Estuaries are generally more productive than coastal areas, and are often more sensitive to pollutants. Moreover, the flushing characteristics of estuaries may be considerably less than for open coastal areas, especially during periods of reduced freshwater input. Thus, for a given discharge size, there is a higher potential for discharge-related impact in estuaries than in open coastal areas. Consequently, it will be more difficult for small applicants that discharge into estuaries to demonstrate absence of adverse ecological effects without conducting onsite field studies. For estuarine discharges, field studies may not be necessary if the discharge is less than 2.5 MGD (rather than 5.0 MGD for open coastal discharges) and the outfall and receiving water characteristics identified under Question D.1 above are satisfied.

Estuarine discharges are also subjected by section 301(h) regulations to increased information requirements associated with allowable effects within the ZID and interference with migratory pathways. Thus, field data collections may be needed to assess within-ZID biological effects (benthic community structure and bioaccumulation) if predictive analyses (guidance for A.3 above) indicate the potential for any substantial accumulation of discharged solids near the outfall.

5. *For improved discharges, will the proposed improved discharge(s) comply with the requirements of 40 CFR 125.61(a) through 40 CFR 125.61(d)? [40 CFR 125.61(e)]*

This question involves a predictive demonstration by the applicant. The applicant must demonstrate that the proposed improvements to the discharge will result in compliance with sections 125.61(a) through 125.61(d). This demonstration may be accomplished by conducting effluent transport or sediment accumulation analyses for the improved discharge as described under Question III.A.3 above, or by a comparison with conditions near discharges which are similar to the proposed improved discharge and are located in similar receiving water environments.

6. *For altered discharge(s), will the altered discharge(s) comply with the 40 CFR 125.61(a) through 125.61(d)? [40 CFR 125.61(e)]*

Applicant's requesting modifications for altered discharges may use similar predictive methods to those described for improved discharges; the applicant is to demonstrate that the reduction in treatment level will still enable compliance with sections 125.61(a) through 125.61(d).

7. *If your current discharge is to stressed waters, does or will your current or modified discharge: [40 CFR 125.61(f)]*

   a. *contribute to, increase, or perpetuate such stressed condition?*
   b. *contribute to further degradation of the biota or water quality if the level of human perturbation from other sources increases?*
   c. *retard the recovery of the biota or water quality if human perturbation from other sources decreases?*

If a BIP does not exist in the vicinity of an outfall because of pollution from sources other than the applicant's modified discharge, the applicant is to demonstrate that its modified discharge does not or will not contribute to, increase or perpetuate stressed biological conditions. The stressed water demonstration requires difficult predictions involving spatial and temporal trends in biological communities and water quality conditions. These assessments are considerably more complex than those required for discharges into unstressed waters, and would in all cases require the collection of site-specific field data to be used in responding to this question.

The basic comparison for stressed waters involves unstressed and stressed control sites in addition to sites near the outfall. The applicant should use the unstressed control data or historical data to document the differences between the stressed biological communities in the receiving water body and those communities that would occur in the area in the absence of pollutant stress. The contribution of the applicant's discharge to existing pollutant stresses should be evaluated by comparing biological communities near the outfall with those at the stressed control site(s). Determination of the effects of the discharge on future degradation or recovery if the level of other pollutant sources changes involves predictive analysis of biological response to future trends in water quality conditions. Small applicants that discharge to stressed waters should consult Chapters VII and IX for additional guidance.

E. *Impacts of Discharge on Recreational Activities [40 CFR 125.61(d)]*

It is necessary to ensure that the modified discharge: 1) will meet water quality standards relevant to recreational activities beyond the zone of initial dilution, and 2) will not cause legal restrictions on recreational activities which would be lifted or modified by upgrading the applicant's POTW to secondary treatment.

1. *Describe the existing or potential recreational activities likely to be affected by the modified discharge(s) beyond the zone of initial dilution.*

All recreational activities currently occurring within the bay, estuary, or an 8-km radius of the discharge should be identified, i.e., swimming, boating, fishing, shellfish harvesting, underwater diving, picnicking, other beach activities. Any additional potential future recreational activities should also be identified, i.e., new ports, boat harbors, etc. A map should be provided indicating the location of current recreational activities, the location of the current discharge and the modified discharge, if different. Qualitative, or whenever possible, quantitative information should be provided indicating the extent of the existing activities. This could include: number of boats or slips in the area, species of fish and shellfish taken, size of catch, number of beach user days.

2. *What are the existing and potential impacts of the modified discharge(s) on recreational activities? Your answer should include, but not be limited to, a discussion of fecal coliforms.*

Water quality standards, particularly coliform bacteria standards, for protecting recreational uses, should be provided. The designation of the water classifications within 8 km of the discharge should be indicated. To confirm compliance with standards relevant to recreational activities, any required coliform bacteria monitoring data for the effluent, at the ZID boundary, and on the adjacent shoreline should be submitted. If shoreline areas are not normally monitored, sampling should occur on the shore near high water-activity areas. If non-compliance with coliform bacteria standards is noted, an explanation and proposed corrective measures should be provided. Other sources of coliform bacteria present in the area which could be contributing to the problem should be identified and the relative contribution estimated.

3. *Are there any Federal, State or local restrictions on recreational activities in the vicinity of the modified discharge(s)? If yes, describe the restrictions and provide citations to available references.*

Any federal, state, or local restrictions or closures relating to the discharge and recreational activites should be identified. The nature of restrictions, the date implemented, and the agency responsible should be indicated.

4. *If recreational restrictions exist, would such restrictions be lifted or modified if you were discharging a secondary treatment effluent?*

If restrictions are in place, the relation of the restriction to the current/modified discharge quality should be established. If an improvement in the discharge quality would modify or eliminate the restriction on recreational activites, this should be indicated. In all such events, it should be determined if secondary treatment would provide sufficient discharge improvement to modify the restriction.

F. *Establishment of a Monitoring Program (40 CFR 125.62)*

1. *Describe the biological, water quality, and effluent monitoring programs which you propose to meet the criteria of 40 CFR 125.62.*

2. *Describe the sampling techniques, schedules, and locations, analytical techniques, quality control and verification procedures to be used.*

General guidance on the design and execution of monitoring programs is provided in Chapter IX and in a separate document entitled "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine

Waters." Monitoring programs for plant effluent would typically include flow, BOD_5, suspended solids, pH, oil and grease, and coliform bacteria. Nutrients, dissolved oxygen, settleable solids, floating particulates, and temperature may also be useful. The frequency required for effluent monitoring of toxic substances and pesticides will depend on the probability of toxic substances or pesticides being present. This probability will be affected by industrial and nonindustrial sources as well as any associated control programs.

The water quality monitoring program should include sampling near the ZID and at a control site as well as in near-shore areas or other potentially important sites. Important variables include dissolved oxygen, temperature, pH, salinity, suspended solids and/or light transmittance and coliform bacteria. Sampling frequencies should conform to state requirements. Initially, sampling during the critical environmental periods should be adequate. The proposed monitoring program should be described and a map of the station locations submitted.

Biological monitoring requirements are minimized for small discharges located at water depths greater than 10 m if an adequate demonstration (e.g., response to III.A.3 above) is supplied to indicate that there will be negligible accumulation of discharged solids near the modified discharge. Such small applicants must still, to the extent practicable, conduct periodic surveys of the biological communities and populations most likely affected by the modified discharge, but are generally excused from the other specific elements of biological monitoring set forth in section 125.62(b)(1). See section 125.62(b)(2).

More extensive biological monitoring is required by section 301(h) regulations for small discharges not meeting the above criteria. Further guidance is provided in Chapter IX of this document. However, because of the low potential impact of small discharges, it is expected that proposed monitoring programs will generally include only limited assessment of those biological communities most likely to be affected by the discharge. The section 301(h) regulations state that biological monitoring programs for applicants not meeting the above criteria should include in addition to the periodic sampling of selected biological communities under section 125.62(b)(1)(i) the following study types:

- Periodic determination of bioaccumulation of toxic substances

- Sampling of the sediments

- Periodic assessments of fisheries (if present).

Each of the above biological monitoring program elements is discussed briefly below. The applicant's monitoring plan should include only those study aspects which are practicable in the site-specific receiving water environment. In cases where the applicant considers that one or more of the aforementioned study types are not practicable, a justification for their proposed deletion from the monitoring program should be provided. Examples of situations in which reductions in the frequency or extent of biological surveys would be allowed include conditions of high currents or adverse climatic periods and periods of low biological variability or extremely low productivity.

For small applicants, the required biological monitoring program would generally involve a small number of sampling sites. The sampling areas would most likely correspond to the minimum number necessary for making required BIP comparisons at ZID-boundary and control sites. Small discharges into saline estuarine environments should also include monitoring of within-ZID biological communities. All small applicants should also include sampling of any distinctive habitat of limited distribution occurring in the vicinity of the discharge.

Bioaccumulation determinations are to be conducted by small applicants not meeting the water depth and sediment accumulation criteria. In situ bioassays may also be necessary on a case-by-case basis. When conducting in situ bioassays, exposures of bivalve molluscs or other test organisms should be conducted as close as practicable to the ZID boundary and at a reference area. If bioaccumulation studies are required, the applicant should use locally important recreational or commercial fish or invertebrates.

Sampling of sediments, by small applicants not meeting the water depth and sediment accumulation criteria, to determine the accumulation of toxic substances is to be conducted in the vicinity of the discharge and at control sites. Within-ZID sediment sampling should be included for saline estuarine discharges. Monitoring for bioaccumulation of toxic substances in indigenous organisms should be conducted if sediment analyses indicate the presence of elevated or increasing concentrations of toxic substances.

If recreational or commercial fisheries are present in areas potentially affected by the discharge, the applicant must also conduct periodic assessments of those fisheries. These evaluations must reflect an understanding of the potential impacts of the discharge on the fisheries. The periodicity and level of fishery surveys will depend on factors such as the size and location of the discharge, concentrations of toxic substances in the effluent, species harvested, and the importance of the commercial or recreational fishery.

3. *Describe the personnel and financial resources available to implement the monitoring programs upon issuance of a modified permit and to carry it out for the life of the modified permit.*

A plan indicating the number and type of personnel, facilities, and equipment should be provided. The cost of the program should be estimated in order to determine if sufficient resources will be available to carry out the program.

G. *Effect of Discharge on Other Point and Nonpoint Sources (40 CFR 125.63)*

1. *Does (will) your modified discharge(s) cause additional treatment or control requirements for any other point or nonpoint pollution source(s)?*

2. *Provide the determination required by 40 CFR 125.63(b) or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.*

The section 301(h) regulations require an analysis of whether a decreased treatment level at the applicant's discharge would require other pollution sources in the vicinity to increase their treatment levels or apply other additional controls.

For open coastal waters, a list of discharges within the anticipated impact area of the applicant's modified discharge should be provided. The subsequent dilution at each outfall can be estimated using Table VI-9 in Chapter VI of this document. The total dilution is the initial dilution times the subsequent dilution. If the effect of the applicant's discharge is small at other source(s), no further analysis may be needed. If not, an analysis of compliance with water quality standards at the other discharger sites is appropriate for determining the effects of the applicant's discharge at these sites. For most small POTW discharges, the effects on other sources should be negligible.

In estuaries where outfalls are close together, effects on other sources are possible. A similar approach as above can be used to estimate the total dilution at the other outfalls.

H. Toxics Control Program (40 CFR 125.64)

1. a. Do you have any known or suspected industrial sources of toxic pollutants and pesticides?
   b. If no, provide the certification required by 40 CFR 125.64(a)(2).
   c. If yes, provide the results of wet and dry weather effluent analyses for toxic pollutants and pesticides.
   d. Provide an analysis of known or suspected industrial sources of toxic pollutants and pesticides identified in (1)(c) above.

2. Do you have an approved industrial pretreatment program?

   a. If yes, provide the date of EPA approval.
   b. If no, and if required by 40 CFR 403 to have an industrial pretreatment program, provide a proposed schedule for development and implementation of your

industrial pretreatment program to meet the requirements of 40 CFR Part 403.

3. *Describe the public education program you propose to minimize the entrance of nonindustrial toxic pollutants and pesticides into your treatment system.*

4. a. *Are there any known or suspected water quality, sediment accumulation, or biological problems related to toxic pollutants or pesticides from your modified discharge(s)?*
   b. *If no, provide the certification required by 40 CFR 125.64(d)(2) together with available supporting data.*
   c. *If yes, provide a schedule for development and implementation of nonindustrial toxics control programs to meet the requirements of 40 CFR 125.64(d)(3).*

Small applicants that can certify that there are no known or suspected 1) industrial sources of toxic pollutants and pesticides as documented by an industrial user survey as described in 40 CFR 403.8(f)(2) or 2) water quality, sediment accumulation, or biological problems related to toxic pollutants or pesticides from the modified discharge, need only provide the certifications requested by H.1.b and H.4.b and develop the public education program requested by H.3. Public education programs may include preparation of newspaper articles, posters, or radio and television announcements designed to increase public awareness of the need for proper disposal of waste oils, solvents, herbicides, pesticides, and any other substances containing toxic pollutants and pesticides.

All other small applicants need to respond to all of the toxic control program questions and are referred to Chapter IX of this document for additional guidance.

IV. LARGE APPLICANT QUESTIONNAIRE

I. INTRODUCTION

This questionnaire is to be used by large applicants for modification of secondary treatment requirements under section 301(h) of the Clean Water Act (CWA). A large applicant has a population contributing to its wastewater treatment facility of at least 50,000 or a projected average dry weather flow of its discharge of at least 5.0 million gallons per day (MGD, 0.22 m^3/sec) [40 CFR 125.58(c)].

The questionnaire is in two sections, a general information and basic requirements section and a technical evaluation section. Satisfactory completion of this questionnaire is necessary to enable EPA to determine whether the applicant's modified discharge meets the criteria of section 301(h) and EPA regulations (40 CFR Part 125, Subpart G).

Where applicants diligently try but are unable to collect and submit all the information at the time of application, EPA requires that a plan of study for gathering and submitting the data be provided with the application. 40 CFR 125.59(f) states the procedures governing such post-application data collection activities.

Guidance for responding to the questions is provided by the Revised Section 301(h) Technical Support Document. Where available information is incomplete and the applicant needs to collect additional data during the period it is preparing the application, EPA encourages the applicant to consult with EPA prior to data collection and submission of its application. Such consultation, particularly if the applicant provides a plan of study, will help assure that the proper data are gathered in the most efficient manner.

This chapter provides specific guidance for completing the Large Applicant Questionnaire. For this purpose, the Large Applicant

Questionnaire (printed in italics) is set forth along with associated guidance (printed in conventional type). Applicants are expected to use all available data for responding to the questionnaire. If it appears that additional data are needed for response to individual questions, the applicant is encouraged to develop a plan of study and consult with EPA prior to collecting the additional data and submitting it with the completed application. After the December 29, 1982, application deadline, collection of additional data to support an application (or application revision) must be authorized or requested by EPA and must be preceded by submittal of a plan of study [40 CFR 125.59(f)]. Guidance on plans of study is provided in Chapter X. Applicants submitting revised applications should refer to 40 CFR 125.59(d).

II. GENERAL INFORMATION AND BASIC DATA REQUIREMENTS

Applicants should answer all questions; where your response to a question is "yes", "no", or "not applicable," explain the basis for your response. Where your answer indicates that you cannot meet a regulatory or statutory criteria, discuss why you believe you qualify for a section 301(h) variance.

Where your response to a question is incomplete, EPA may request the collection of additional data before the application is evaluated.

A. Treatment System Description

1. *Are you applying for a modification based on a current discharge, improved discharge, or altered discharge as defined in 40 CFR 125.58? [40 CFR 125.59(a)]*

See Chapter III for additional descriptions and examples of these terms.

2. *Description of the Treatment/Outfall System [40 CFR 125.61(a) and 125.61(e)]*

   a. *Provide detailed descriptions and diagrams of the treatment system and outfall configuration which you propose to satisfy the requirements of section 301(h) and*

40 CFR Part 125, Subpart G. What is the total discharge design flow upon which this application is based?

b. Provide a map showing the geographic location of the proposed outfall(s) (i.e., discharge). What is the latitude and longitude of the proposed outfall(s)?

c. For a modification based on an improved or altered discharge, provide a description and diagram of your current treatment system and outfall configuration. Include the current outfall's latitude and longitude, if different from the proposed outfall.

Most of the above information can be found in Section 1-13 of the NPDES Standard Form A submitted with the application.

3. Effluent Limitations and Characteristics [40 CFR 125.60(b) and 125.61(e)(2)]

a. Identify the final effluent limitations for five-day biochemical oxygen demand (BOD_5), suspended solids, and pH upon which your application for a modification is based:

- *BOD_5 _____ mg/l*
- *Suspended solids _____ mg/l*
- *pH _____ (range)*

Please provide the effluent limitations you are requesting to be stipulated in your section 301(h) modified NPDES permit.

b. Provide data on the following effluent characteristics for your current discharge as well as for the modified discharge if different from the current discharge:

Flow (m^3/sec):

- *minimum*
- *average dry weather*
- *average wet weather*

- *maximum*
- *annual average*

BOD$_5$ (mg/l) for the following plant flows:

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Suspended solids (mg/l) for the following plant flows:

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Toxic pollutants and pesticides (ug/l):

- *list each identified toxic pollutant and pesticide*

pH:

- *minimum*
- *maximum*

Dissolved oxygen (mg/l, prior to chlorination) for the following plant flows:

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Immediate dissolved oxygen demand (mg/l)

Most of the above information can be found in plant operating records. Provide results of the wet and dry weather chemical analyses for toxic pollutants and pesticides as discussed in Chapter VIII of this document as requested above. List all toxics detected including those at concentrations less than 10 ug/l. Additional guidance on sampling and chemical analyses for conventional and toxic pollutants is presented in Chapter IX on Monitoring. The IDOD values can be estimated or measured using the procedures presented in Chapter VI.

4. *Effluent Volume and Mass Emissions [40 CFR 125.61(e)(2) and 125.65]*

   a. *Provide detailed analyses showing projections of effluent volume (annual average, m^3/sec) and mass loadings (mt/year) of BOD_5 and suspended solids for the design life of your treatment facility in five-year increments. If the application is based upon an improved or altered discharge, the projections must be provided with and without the proposed improvements or alterations.*

   b. *Provide projections for the end of your five-year permit term for 1) the treatment facility contributing population and 2) the average daily total discharge flow for the maximum month of the dry weather season.*

Projections of effluent volume and mass emissions may be based on expected population and service area changes over the design life of your treatment facility.

5. *Average Daily Industrial Flow (m^3/sec) (40 CFR 125.64) Provide or estimate the average daily industrial inflow to your treatment facility for the same time increments as in question II.A.4.a above.*

Annual average flow data will generally be sufficient for nonseasonal (i.e., continuous operation) industries. For seasonal industries, please provide average daily flows for the period(s) of operation. Please provide flows for each industrial contributor.

6. *Combined Sewer Overflows [40 CFR 125.65(b)]*

   a. *Does (will) your collection and treatment system include combined sewer overflows?*
   b. *If yes, provide a description of your plan for minimizing combined sewer overflows to the receiving water.*

Please provide information on location(s), flow quantity(s), and frequency of overflows along with a narrative description and schedule of your plan for minimizing the discharge of combined sewer overflows to the receiving water.

7. *Outfall/Diffuser Design. Provide the following data for your current discharge as well as for the modified discharge, if different from the current discharge: [40 CFR 125.61(a)(1)]*

   - *diameter and length of the outfall(s) (meters)*
   - *diameter and length of the diffuser(s) (meters)*
   - *angle(s) of port orientations(s) from horizontal (degrees)*
   - *port diameter(s) (meters)*
   - *orifice contraction coefficient(s), if known*
   - *vertical distance from mean lower low water (or mean low water) surface and outfall port(s) centerline (meters)*
   - *number of ports*
   - *port spacing (meters)*
   - *design flow rate for each port if multiple ports are used (m^3/sec)*

The above data should be available from the engineering drawings for your outfall/diffuser system.

B. *Receiving Water Description*

1. *Are you applying for a modification based on a discharge to the ocean or to a saline estuary [40 CFR 125.58(q)]? [40 CFR 125.59(a)]*

"Ocean waters" is defined in 40 CFR 125.58(1) and are those coastal waters landward of the baseline of the territorial seas, the deep waters of the territorial seas, or the waters of the contiguous zone. Territorial seas extend 3 miles outward from the baseline and the contiguous zone extends an additional 9 miles.

"Saline estuarine waters" is defined in 40 CFR 125.58(q) and means those semi-enclosed coastal waters which have a free connection to the territorial sea, undergo net seaward exchange with ocean waters, and have salinities comparable to those of the ocean. Generally, these waters are near the mouth of estuaries and have cross-sectional, annual mean salinities greater than 25 parts per thousand. It should be noted, however, that 25 ppt is used as a general test in section 125.58(q) and the failure of the receiving water to meet this salinity concentration does not absolutely preclude eligibility for consideration under section 301(h). However, where salinities fall significantly below this concentration, applicants should be careful to document that the waters into which they discharge meet the other requirements of section 125.58(q), i.e., free connection to the territorial sea and net seaward exchange with ocean waters.

2. *Is your current discharge or modified discharge to stressed waters? If yes, what are the pollution sources contributing to the stress? [40 CFR 125.61(f)]*

"Stressed waters" are defined in 40 CFR 125.58(t) and means receiving water environments in which a balanced indigenous population (BIP) does not exist as a result of factors other than the applicant's modified discharge. If an applicant's discharge is to stressed waters, the application must demonstrate that the modified discharge will not contribute to the stress or retard recovery if other pollutant sources are diminished and/or removed.

If your answer to this question is yes, please provide a list of the locations and descriptions of the other point and nonpoint sources contributing to the stress. If no, please state the basis for this conclusion.

3. *Provide a description and data on the seasonal circulation pattern in the vicinity of your current and modified discharge(s). [40 CFR 125.61(a)]*

This information should include a description of current patterns and general density structure on a seasonal basis as well as the variation over a tidal cycle. Hydraulic residence times and flushing characteristics should be described for discharges into estuaries and semi-enclosed bodies of water. Any periods of natural upwelling should be described, including changes in the current patterns and stratification. U.S. Department of Commerce (U.S. DOC 1979a, b) tidal current prediction tables are a useful source for this information.

4. *Oceanographic Conditions in the Vicinity of the Current and Proposed Modified Discharge(s). Provide data on the following: [40 CFR 125.61(a)]*

   - *lowest ten percentile current speed (m/sec)*
   - *predominant current speed (m/sec) and direction (true) during the four seasons*
   - *period(s) of maximum stratification (months)*
   - *period(s) of natural upwelling events (duration and frequency, months)*
   - *density profiles during period(s) of maximum stratification*

The vertical and areal distribution of currents and water density in both the nearfield and farfield are needed to evaluate plume dilution and transport of the wastefield. Data collected from previous studies or nearby similar areas will often be appropriate.

The number and location of sampling stations needed to provide sufficient data will depend on the bathymetric and hydrographic environment. For open coastal sites with uniform bathymetry and minimal freshwater inflows, as few as five stations may be adequate. However, for an estuary with significant freshwater inflow and highly variable bathymetry, as many as 50 stations may be necessary.

For existing discharges, the measurements should be made in the vicinity of the outfall but outside the region directly influenced by the discharge. For relocated outfalls, measurements should be made in the vicinity of the proposed discharge location. Current data should be obtained near the surface, at the approximate depth of the wastefield, and in the bottom 2 m (6.6 ft) of the water column. Water depths at the stations should be similar to the depth of the current and relocated outfalls (if present).

The duration of time within which these measurements should be obtained is dependent on the characteristics of the principal components of the current regime and the variability of the density structure. If the currents are predominantly tidal, the current measurements should be at approximately 30 minute intervals for not less than 29 days. If seasonal changes in oceanographic conditions are significant (upwelling, shoreward transport, high and low runoff) then information should be obtained for each season. The question presumes that the period(s) of maximum stratification will be critical for calculating initial dilutions. Field data on other potentially critical periods may be necessary for determining whether this is true.

Reduction and presentation of data should be of sufficient detail to support the interpretation and analyses performed in the application. Forms of data reduction and presentation which are recommended are:

> Current Persistence Tables - Summary of the frequency and duration of specific current speed and direction events. For example, currents with speeds between 10 and 15 cm/sec between directions of 260 and 280 degrees (t) for durations of 1 hour or more occur for 18 percent of the data record.
>
> Current Speed and Direction Frequency Tables - Frequency of specific current speed and direction intervals. For example, currents with speeds between 5 and 10 cm/sec occurred for 20 percent of the data record and currents with directions between 80 and 90 degrees (T) occurred for 23 percent of the data record.

Net Coastal Orthogonal Component Analysis - By determining the predominant direction(s) of current flow, a primary axis for orthogonal component decomposition of each current vector, can be selected. The net component relative to each axis can then be determined. If the currents do not exhibit predominate flow direction(s), an axis parallel to the local bathymetry or in the direction of an area of significance can be selected.

Current Mean and Variance - For the predominate direction(s) of current flow or the selected primary axis, the mean and variance of the current speed can be determined.

Guidance concerning the instrumentation and methods for collection of oceanographic data can be obtained from the document "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters."

5. *Ambient Water Quality Conditions During the Period(s) of Maximum Stratification: at the zone of initial dilution (ZID) boundary, at other areas of potential impact, and at control stations: [40 CFR 125.61(a)(2)]*

   a. *Provide profiles (with depth) on the following for the current discharge location and for the modified discharge location, if different from the current discharge:*

      - *BOD_5 (mg/l)*
      - *Dissolved oxygen (mg/l)*
      - *Suspended solids (mg/l)*
      - *pH*
      - *Temperature (^oC)*
      - *Salinity (ppt)*
      - *Transparency (turbidity, percent light transmittance)*
      - *Other significant variables (e.g., nutrients, toxic pollutants and pesticides, fecal coliforms)*

Sampling of nutrients, coliform bacteria and other significant variables may be conducted at selected depths. Secchi disc depth data should be provided if transparency data are not available. Ambient water quality data collection procedures and requirements are discussed in the document entitled "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters" and in Chapter IX of this document.

For each survey, the following information should be submitted along with the data: a map showing exact locations of the stations, the depth at which the measurements were taken, and the sampling dates and times. The applicant should state whether effluent was discharging from the outfall at the time of the survey and should provide the flow rate, BOD_5 concentration, pH, and suspended solids concentration of the effluent, if available. Any unusual meteorological or oceanographic conditions (e.g., storms, onshore transport) should be discussed. If current data or other oceanographic information are available at the time of the survey, the direction of movement of the wastefield should be described.

b. *Are there other periods when receiving water quality conditions may be more critical than the period(s) of maximum stratification? If so, describe these other critical periods and the data requested in 5.a. for the other critical period(s). [40 CFR 125.61(a)(1)]*

Other periods when water quality conditions may be more critical include periods of maximum hydraulic loading from the POTW; periods of exceptional biological activity; periods of low background water quality; periods of low net circulation; periods of low effective net flushing or low intertidal mixing; and periods of minimum stratification.

6. *Provide data on steady state sediment dissolved oxygen demand and dissolved oxygen demand due to resuspension of sediments in the vicinity of your current and modified discharge(s) (mg/l/day).*

Dissolved oxygen depletion due to steady sediment demand and sediment resuspension depends on sediment composition (e.g., grain size distribution and organic content) and accumulation rates, current speeds, and circulation patterns. When possible, field and/or laboratory measurements may be used to determine oxygen consumption rates. If such measurements are made, the results and procedures used should be described.

C. *Biological Conditions*

1. *Provide a detailed description of representative biological communities (eg, plankton, macrobenthos, demersal fish, etc.) in the vicinity of your current and modified discharge(s): within the ZID, at the ZID boundary, at other areas of potential discharge-related impact, and at reference (control) sites. Community characteristics to be described shall include (but not be limited to) species composition; abundance; dominance and diversity; spatial/temporal distribution; growth and reproduction; disease frequency; trophic structure and productivity patterns; presence of opportunistic species; bioaccumulation of toxic materials; and the occurrence of mass mortalities.*

The biological information shall be used to describe the existing conditions near the applicant's discharge and to evaluate whether or not a BIP exists (or will exist) near the current and modified discharge(s). The descriptive information shall be used as the basis for the applicant's response to Question D.1. in the Technical Evaluation.

2. a. *Are distinctive habitats of limited distribution (such as kelp beds or coral reefs) located in areas potentially affected by the modified discharge? [40 CFR 125.61(c)]*
   b. *If yes, provide information on type, extent, and location of habitats.*

Distinctive habitats of limited distribution include those marine environments whose protection is of special concern because of their ecological significance or value to man. These habitats include, but are not limited to, coral reefs, kelp beds, sea grass meadows, intertidal or subtidal rock outcroppings, sites of productive fisheries and all areas recognized as marine or estuarine sanctuaries.

The applicant should provide information on all distinctive habitats of limited distribution identified in the vicinity of the outfall and in other areas of the receiving water body which are potentially influenced by the discharge. Sources of information on occurrences of such habitats include:

- Contacts with local offices of state conservation agencies
- Review of literature, especially resource maps available for the general vicinity of the discharge(s).

Since most distinctive habitats are visible to a surface observer, the applicant may also use direct visual observation of the marine environment in the outfall vicinity to determine local occurrences.

If distinctive habitats are identified in the receiving water body, the applicant should provide additional information on the types, locations, and extents of such habitats. This information may be collected from maps, by aerial surveys, or by diver observations.

> *3. a. Are commercial or recreational fisheries located in areas potentially affected by the discharge? [40 CFR 125.61(c)]*
>
> *b. If yes, provide information on types, location, and value of fisheries.*

Documentation of fisheries in the receiving water body is important because of economic and recreational aspects and because of the potential for human consumption of contaminated organisms.

The applicant should provide information on all fishery resources, both utilized and non-utilized, in the outfall vicinity and in other areas potentially influenced by the discharge. The descriptive information presented should include the fishery types, effort levels, economic value and temporal patterns. Emphasis should be placed upon regulatory or health-related factors which prevent utilization of the resource, especially if such factors are related to pollutant contamination. Sources of information include natural resource agencies, public health agencies, local fishermen and academic institutions.

D. *State and Federal Laws [40 CFR 125.60]*

1. Are there water quality standards applicable to the following pollutants for which a modification is requested:

   - Biochemical oxygen demand or dissolved oxygen?
   - Suspended solids, turbidity, light transmission, light scattering, or maintenance of the euphotic zone?
   - pH of the receiving water?

2. If yes, what is the water use classification for your discharge area? What are the applicable standards for your discharge area for each of the parameters for which a modification is requested? Provide a copy of all applicable water quality standards or a citation to where they can be found.

3. Will the modified discharge: [40 CFR 125.59(b)(3)]

   - Be consistent with applicable State coastal zone management program(s) approved under the Coastal Zone Management Act as amended, 16 U.S.C. 1451 et seq.? [See 16 U.S.C. 1456(c)(3)(A)]
   - Be located in a marine sanctuary designated under Title III of the Marine Protection, Research, and Sanctuaries Act (MPRSA) as amended, 16 U.S.C. 1431 et seq. or in an estuarine sanctuary designated under the Coastal Zone Management Act as amended, 16 U.S.C. 1461? If located in a marine sanctuary designated under Title III of the MPRSA, attach a copy of any certification or permit required under regulations governing such marine sanctuary. [See 16 U.S.C. 1432(f)(2)]
   - Be consistent with the Endangered Species Act as amended, 16 U.S.C. 1531 et seq.? Provide the names of any threatened or endangered species that inhabit or obtain nutrients from waters that may be affected by the modified discharge. Identify any critical habitat that may be affected by the modified discharge and evaluate whether the modified discharge will affect

threatened or endangered species or modify a critical habitat. [See 16 U.S.C. 1536(a)(2)]

4. *Are you aware of any state or Federal Laws or regulations (other than the Clean Water Act or the three statutes identified in item 3 above) or an Executive Order which is applicable to your discharge? If yes, provide sufficient information to demonstrate that your modified discharge will comply with such law(s), regulation(s), or order(s). [40 CFR 125.59(b)(3)]*

Applicants should contact the state water quality agency for answers to D.1 and D.2 and the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and state coastal zone management agency for a response to D.3. A list of state water quality agencies, coastal zone management agencies, and regional offices of the NMFS, USFWS, and EPA is provided as Appendix A to this document.

III. TECHNICAL EVALUATION

Answers to the following questions will be used to assess the effects of the modified discharge. The responses will be used by the state agency(s) in their determination (as required by 40 CFR 125.60(b)(2) and 125.63(b)), and by EPA in preparing its decision on the applicant's request for a section 301(h) variance.

Your answers to the following questions must be supported by data and responses from Section II of this questionnaire. The analyses and calculations required below must show the input [supporting] *data for all calculations. Applicants should answer all questions; where your answer to a question is "yes", "no", or "not applicable," explain the basis for your response. Where your answer indicates that you cannot meet a regulatory or statutory criteria, discuss why you believe you qualify for a variance.*

If EPA decides to check calculations in an application, the formulas and methods provided in this document may be used for that purpose. If applicants use methods other than those provided in this document, such methods must be described by the applicant.

A. *Physical Characteristics of Discharge [40 CFR 125.61(a)]*

1. *What is the critical initial dilution for your current and modified discharge(s) during 1) the period(s) of maximum stratification? and 2) any other critical period(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?*

Methods for computation of initial dilution are provided in Chapter V of this document. If other methods are used they should be fully documented. Initial dilutions should be calculated for the period(s) of maximum stratification and other periods of critical environmental conditions.

The availability of sufficient dilution water should be determined based on regional currents and circulation patterns as discussed in Chapter V of this document.

2. *What are the dimensions of the zone of initial dilution for your modified discharge(s)?*

The ZID may be considered to be the bottom area within a distance equal to the water depth from any point on the diffuser and the water column above that area. Alternative methods for calculating ZID dimensions may be used but the ZID may not be larger than mixing zone restrictions in applicable water quality standards. The applicant is encouraged to consult with the state water quality agency on an appropriate method for calculating ZID dimensions.

3. *What are the effects of ambient currents and stratification on dispersion and transport of the discharge plume/wastefield?*

The effects of ambient conditions on effluent dispersion should be determined as described in Chapter V of this document. This analysis is used to compute farfield dissolved oxygen consumption and suspended solids deposition.

4. *Sedimentation of suspended solids*

   a. *What fraction of the modified discharge's suspended solids will accumulate within the vicinity of the modified discharge?*

   b. *What are the calculated area(s) and rate(s) of sediment accumulation within the vicinity of the modified discharge(s) (g/m^2/yr)?*

   c. *What is the fate of settleable solids transported beyond the calculated sediment accumulation area?*

The above questions can be addressed with methods described in Chapter VI of this document. The fate of suspended solids is needed in order to calculate oxygen consumption rates and interpret biological data. Settling velocity distributions of the effluent should be provided, if available. Graphs showing the settling velocity (cm/sec) and percent of solids which settle at that velocity or less are preferred. The suspended solids concentration (mg/l), test conditions, and laboratory procedures used should be described.

B. *Compliance with Applicable Water Quality Standards [40 CFR 125.60(b) and 125.61(a)]*

1. *What is the concentration of dissolved oxygen immediately following initial dilution for the period(s) of maximum stratification and any other critical period(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?*

Dissolved oxygen concentrations are needed to verify that water quality standards will be met. Chapter VI provides methods to compute the dissolved oxygen following initial dilution. This value depends on the dissolved oxygen concentration of the effluent and receiving water, the immediate dissolved oxygen demand (IDOD), and the initial dilution. Normally, the critical period(s) for dissolved oxygen will coincide with the period(s) of maximum stratification.

2. *What is the farfield dissolved oxygen depression and resulting concentration due to BOD exertion of the*

wastefield during the period(s) of maximum stratification and any other critical period(s)?

The farfield oxygen depression determination is needed to assess whether water quality standards will be met in areas away from the ZID. Methods for estimating farfield effects are described in Chapter VI.

3. *What are the dissolved oxygen depressions and resulting concentrations near the bottom due to steady sediment demand and resuspension of sediments?*

An estimate of dissolved oxygen depressions resulting from steady sediment demand and resuspension should be made using the methods described in Chapter VI. If field or laboratory measurements are available, the results can be used in these analyses.

4. *What is the increase in receiving water suspended solids concentration immediately following initial dilution of the modified discharge(s)?*

The suspended solids concentration following initial dilution can be estimated by a simple mass balance calculation as described in Chapter VI. This value depends on the suspended solids concentration of the effluent and receiving water and initial dilution. The suspended solids concentration can affect light transmittance and sensitive biological habitats (e.g., coral reefs) and is used in the analysis of solids deposition.

5. *What is the change in receiving water pH immediately following initial dilution of the modified discharge(s)?*

The pH following initial dilution is needed to verify that water quality standards are met. The pH can be calculated or measured in the laboratory as discussed in Chapter VI of this document.

6. *Does (will) the modified discharge comply with applicable water quality standards for:*

    - *Dissolved oxygen?*

- *Suspended solids or surrogate standards?*
- *pH?*

The applicant should summarize the findings of questions B.1 through B.5 and show that the appropriate standards are met.

7. *Provide the determination required by 40 CFR 125.60(b)(2) or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.*

C. *Impact on Public Water Supplies [40 CFR 125.61(b)]*

1. *Is there a planned or existing public water supply (desalinization facility) intake in the vicinity of the current or modified discharge?*

2. *If yes,*

   a. *what is the location of the intake(s) (latitude and longitude)?*
   b. *will the modified discharge(s) prevent use of the intake(s) for public water supply?*
   c. *will the modified discharge(s) cause increased treatment requirements for the public water supply(s) to meet local, state, and EPA drinking water standards?*

It is not expected that any marine POTW discharges will affect public water supply intakes. However, the applicant should verify that none are located within 16 km (10 mi) of the discharge. Chapter VI provides some background information on coastal desalinization plants. If no desalinization plants or other water supply intakes exist within 16 km (10 mi) of the discharge, no analyses are required. The name of the agencies contacted and the person involved should be listed in the application. If a water supply intake does exist, the location should be shown on a map with the discharge site marked. The travel time to the intake should be estimated using the average current speed. The applicant should show that all water quality standards are met at the intake using the methods discussed in this document.

D. *Biological Impact of Discharge [40 CFR 125.61(c)]*

1. *Does (will) a balanced indigenous population of shellfish, fish, and wildlife exist:*

   a. *immediately beyond the ZID of the current and modified discharge(s)?*

   b. *in all other areas beyond the ZID where marine life is actually or potentially affected by the current and modified discharge(s)?*

Previous review of applications for larger discharges has indicated that structural modifications of marine communities can occur near the applicants' discharges. This question should be addressed in relation to spatial comparisons of biological communities near the discharge and at control areas. The purpose of the question is to determine whether unacceptable adverse impacts occur or will occur beyond the ZID.

The applicant should consult Chapter VII for information on study design and data requirements. The biological community characteristics that might be examined in an evaluation of a BIP include, but are not limited to, species composition, abundance, biomass, dominance and diversity, spatial/temporal distributions, growth and reproduction, disease prevalence, trophic structure, productivity, and presence or absence of pollution indicator species.

The applicant should compare the ranges of biological characteristics among the four specified areas where communities are to be assessed. If differences in biological variables which are attributable to the discharge are detected between study areas (e.g., ZID boundary vs. control), the applicant should assess the spatial extent of those differences. In addition, the magnitude of the effect should be characterized with regard to the relative deviation from control conditions (e.g., percent reduction in species richness), the potential for intertrophic effects (e.g., reductions in fish food organisms) and the potential for involvement of recreationally or commercially important species. Please see Chapter VII for additional guidance.

2. *Have distinctive habitats of limited distribution been impacted adversely by the current discharge and will such habitats be impacted adversely by the modified discharge?*

If distinctive habitats are present in areas potentially influenced by the discharge, the applicant should conduct field surveys to document the extent and condition of those habitats and to evaluate any effects of the discharge. The applicant should also provide a detailed evaluation of available historical information on the spatial distribution of any distinctive habitats near the outfall and in nearby control areas. Trends in spatial occurrence should be evaluated relative to historical discharges by the applicant and relative to other water quality or biological factors which potentially influence the habitat.

3. *Have commercial or recreational fisheries been impacted adversely by the current discharge (e.g., warnings, restrictions, closures, or mass mortalities) or will they be impacted adversely by the modified discharge?*

If fishery resources are present in areas potentially influenced by the discharge, the applicant should assess the effects of the outfall on these resources by analyzing catch records, market acceptability, contamination of tissues by toxic substances, prevalance of disease, and harvest warnings/closures.

Field surveys may be required to document distribution patterns, migratory pathways and status of spawning areas. These studies should generally emphasize potential outfall effects on demersal fishes, epibenthic mega-invertebrates and filter-feeding bivalve molluscs since these biotic groups are most susceptible to effects of solids accumulation, tissue contamination and induction of disease.

4. *Does the current or modified discharge cause the following within or beyond the ZID: [40 CFR 125.61(c)(3)]*

   a. *mass mortality of fishes or invertebrates due to oxygen depletion, high concentrations of toxics or other conditions?*

b. an increased incidence of disease in marine organisms?

c. an abnormal body burden of any toxic material in marine organisms?

d. any other extreme, adverse biological impacts?

This question requires the assessment of several specific potential impacts of POTW discharges. The applicant should review and summarize available information on occurrences of mass mortalities of marine organisms in the receiving water environment. The suspected cause(s) of mass mortalities should be evaluated to determine if any mass mortalities could have resulted from the applicant's discharge. Evaluation of the occurrences of, or potential for, mass mortalities is especially important for applicants with discharges into estuaries or enclosed embayments. Dissolved oxygen deficiencies in these environments with limited flushing characteristics may result from BOD inputs or algal decomposition following bloom conditions. Evaluation of disease incidence or tissue contamination in marine organisms should be conducted by spatial comparisons of communities near the discharge (ZID and ZID boundary) with those in control areas.

5. For discharges into saline estuarine waters: [40 CFR 125.61(c)(4)]

a. Does or will the current or modified discharge cause substantial differences in the benthic population within the ZID and beyond the ZID?

b. Does or will the current or modified discharge interfere with migratory pathways within the ZID?

c. Does or will the current or modified discharge result in bioaccumulation of toxic pollutants or pesticides at levels which exert adverse effects on the biota within the ZID?

Estuaries are generally more productive than coastal areas, and are often more sensitive to pollutants. They also serve as spawning and nursery grounds for many invertebrates and fishes. Moreover, the flushing characteristics of estuaries may be considerably less than open coastal areas, especially during periods of reduced freshwater input. Thus, for a given discharge size, there is generally a higher potential impact in estuaries than in open coastal environments.

Additional information is required for saline estuarine discharges. EPA regulations [40 CFR 125.61(c)(4)] require applicants to demonstrate that there are no substantial differences between the benthic communities within the ZID and beyond the ZID. Hence, applicants discharging into saline estuaries must conduct comparisons of within-ZID and ZID-boundary benthic communities with benthic communities at the reference site(s).

The applicant should also assess interference potential of the discharge with migratory pathways within the ZID. In conducting this assessment the applicant may calculate the proportion of the cross sectional area of the estuary that is influenced by the ZID. The potential for migratory interference may then be evaluated by a consideration of the relative size and characteristics of the discharge-affected area and its location in the estuary with respect to known migratory pathways.

Applicants with saline estuarine discharges are also to assess the bioaccumulation of toxic substances within the ZID. If elevated or increasing concentrations of toxic substances are found in fish or shellfish, the applicant should assess the potential for adverse impacts such as restrictions on human use (e.g., FDA Action Levels), induction of disease, or interference with fish and shellfish growth or reproduction.

6. *For improved discharges, will the proposed improved discharge(s) comply with the requirements of 40 CFR 125.61(a) through 125.61(d)? [40 CFR 125.61(e)]*

EPA regulations require applicants who propose discharge improvement(s) to demonstrate that the improvement(s) will result in compliance with sections 125.61(a) through 125.61(d). This demonstration might be accomplished by comparing conditions at the outfall location with conditions near discharges which are similar to the proposed improved discharge. Assuming that there is a basic similarity in indigenous biota of the receiving environment, such a comparison may be sufficient to predict protection of a BIP. Applicants may also conduct predictive analyses of effluent dispersion and seabed accumulation of solids following discharge improvements.

Applicants whose discharge improvement plans include outfall relocation should describe present biological conditions at both the proposed and current outfall sites. Those applicants are also to predict future biological conditions at the proposed site following relocation of the discharge. Such predictions might be conducted by comparisons with other discharges which are similar to the relocated discharge. Discharges used for such comparisons should be located in receiving environments similar to the applicant's discharge.

7. *For altered discharge(s), will the altered discharge(s) comply with the 40 CFR 125.61(a) through 125.61(d)? [40 CFR 125.61(e)]*

EPA regulations require applicants requesting modifications for altered discharges to demonstrate that a treatment level less than that currently achieved will nonetheless enable compliance with sections 125.61(a) through 125.61(d). This demonstration requires a difficult prediction since the applicant is to show how an increase in pollutant discharges will not result in adverse effects on indigenous biota.

Applicants proposing altered discharges should initially document any impacts of the current discharge. If the applicant's current discharge does not result in maintenance of a BIP, the applicant should demonstrate how outfall improvements (e.g., relocation) would operate in conjunction with the reduced treatment level to enable compliance with the BIP requirements. If no outfall improvements are proposed in such cases, it would not be possible for the applicant to make the necessary BIP demonstration since biological conditions would be expected to deviate further from a BIP under increased pollutant loadings.

If available data indicate that the applicant's current discharge does not result in adverse ecological impact, the applicant should conduct predictive analyses to demonstrate a continued absence of impact with the altered discharge. Such analyses may include the use of sediment modeling procedures as described in Chapter VI or comparisons with other discharges.

8. *If your current discharge is to stressed waters, does or will your current or modified discharge: [40 CFR 125.61(f)]*

a. *contribute to, increase, or perpetuate such stressed condition?*

b. *contribute to further degradation of the biota or water quality if the level of human perturbation from other sources increases?*

c. *retard the recovery of the biota or water quality if human perturbation from other sources decreases?*

If a BIP does not exist in in the vicinity of an outfall because of pollution from sources other than the applicant's modified discharge, the applicant is to demonstrate that its modified discharge does not or will not contribute to, increase, or perpetuate stressed biological conditions. In addition to all other requirements, the applicant should show that the following three conditions are met:

- The differences are documented and assessed between the biological conditions that currently exist in the general vicinity of the outfall and the balanced indigenous population that would occur there in the absence of all human disturbances. The assessment of the degree of ecological alterations can be accomplished by comparisons of environmental conditions near the outfall with historic data collected in the same area or from similar habitats elsewhere and by spatial comparisons on a larger geographic scale that includes comparable, but unpolluted habitats (e.g., unstressed control sites). The applicant also is to assess temporal trends that would indicate whether the degree of ecological alteration is increasing or decreasing.

- The applicant demonstrates that its discharge is not contributing to the present biological alterations associated with the stressed waters outside of the ZID. This demonstration includes all of the section 301(h) biological assessments that would be required of a discharge into unstressed waters. It differs because the biota within and immediately beyond the ZID are to be compared with the biota existing at stressed reference sites, rather than unpolluted reference sites. In conducting this comparison, applicants may need to consider spatial gradients of stress from other pollutant sources, thereby determining whether the degree of stress at the discharge site is equal to, greater than, or less than that at the stressed reference site.

- The applicant demonstrates that its discharge will not contribute to further degradation of the biota if the level of pollution from other sources increases, and that its discharge will not retard the recovery of the biota if the level of pollution from other sources decreases. This demonstration requires a prediction of biological responses to future pollution levels. Any quantity of pollutant discharge into stressed waters theoretically may contribute to the existing level of stress and may therefore retard recovery if other sources are removed. In assessing the importance of this contribution the applicant should address the magnitude and extent of the impact. Similarly, in addressing the degree of potential retardation, the relative importance of the retardation in light of the rate and extent of recovery possible is of primary interest.

E. *Impacts of Discharge on Recreational Activities [40 CFR 125.61(d)]*

It is necessary to ensure that the modified discharge will: 1) meet water quality standards relevant to recreational activities beyond the zone of initial dilution, and 2) will not cause legal restrictions on activities which would be lifted or modified by upgrading applicant's POTW to secondary treatment.

1. *Describe the existing or potential recreational activities likely to be affected by the modified discharge(s) beyond the zone of initial dilution.*

All recreational activities currently occurring within the bay, estuary, or an 8-km radius of the outfall should be identified, i.e., swimming, boating, fishing, shellfishing, underwater diving, picnicking, other beach activities. Any additional potential future recreational activities should also be identified, i.e., new ports, boat harbors, etc. A supplementary map should be provided indicating the location of current activities, along with the location of the existing and/or proposed outfall. Qualitative or, whenever possible, quantitative information should be provided indicating the extent of the existing activities. This could include; number of boats or slips in the area, species of fish and shellfish taken, size of catch, number of beach user days.

2. *What are the existing and potential impacts of the modified discharge(s) on recreational activities? Your answer should include, but not be limited to, a discussion of fecal coliforms.*

Water quality standards, particularly coliform bacteria standards, for protecting recreational uses, should be provided. The designation of the water classifications within 8 km of the discharge should be indicated. The schedule and frequency of chlorination should be established. To confirm compliance with standards relevant to recreational activities, any required coliform bacteria monitoring data for the effluent, at the ZID boundary, and on the adjacent shoreline should be submitted. If shoreline areas are not normally monitored, sampling should occur on the shore near high water-activity areas. If noncompliance with coliform bacteria standards is noted, an explanation and corrective measures should be provided. Other sources of coliform bacteria present in the area which could be contributing to the problem should be identified.

3. *Are there any Federal, State or local restrictions on recreational activities in the vicinity of the modified discharge(s)? If yes, describe the restrictions and provide citations to available references.*

Any federal, state, or local restrictions or closures relating to the discharge and recreational activities should be identified. The nature of restrictions, the date implemented, and the agency responsible should be indicated.

4. *If recreational restrictions exist, would such restrictions be lifted or modified if you were discharging a secondary treatment effluent?*

If restrictions are in place, the relation of the restriction to the current/modified discharge quantity and quality should be established. If an improvement in the discharge quality would modify or eliminate the restriction on recreational activities, this should be indicated. In all such events, it should be determined if secondary treatment would provide sufficient discharge improvement to modify the restriction.

F. *Establishment of a Monitoring Program (40 CFR 125.62)*

1. *Describe the biological, water quality, and effluent monitoring programs which you propose to meet the criteria of 40 CFR 125.62.*
2. *Describe the sampling techniques, schedules, and locations, analytical techniques, quality control and verification procedures to be used.*
3. *Describe the personnel and financial resources available to implement the monitoring programs upon issuance of a modified permit and to carry it out for the life of the modified permit.*

General guidance on the design of the monitoring program and the information to be submitted in the application is discussed in Chapter IX of this document and in a separate document entitled "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters."

G. *Effect of Discharge on Other Point and Nonpoint Sources (40 CFR 125.63)*

1. *Does (will) your modified discharge(s) cause additional treatment or control requirements for any other point or nonpoint pollution source(s)?*

Methods for estimating the effect of the discharge on other sources is discussed in Chapter VI of this document.

2. *Provide the determination required by 40 CFR 125.63(b) or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.*

H. *Toxics Control Program (40 CFR 125.64)*

1. a. *Do you have any known or suspected industrial sources of toxic pollutants or pesticides?*
   b. *If no, provide the certification required by 40 CFR 125.64(c)(2).*

2. *Provide the results of wet and dry weather effluent analyses of toxic pollutants and pesticides as required by 40 CFR 125.64(a)(1).*

3. *Provide an analysis of known or suspected industrial sources of toxic pollutants and pesticides identified in 2. above.*

4. *Do you have an approved industrial pretreatment program?*

   a. *If yes, provide the date of EPA approval.*
   b. *If no, and if required by 40 CFR Part 403 to have an industrial pretreatment program, provide a proposed schedule for development and implementation of your industrial pretreatment program to meet the requirements of 40 CFR Part 403.*

5. *Describe the public education program you propose to minimize the entrance of nonindustrial toxic pollutants and pesticides into your treatment system.*

6. *Provide a schedule for development and implementation of nonindustrial toxics control programs to meet the requirements of 40 CFR 125.64(d)(3).*

Guidance for response to these questions is provided in Chapter VIII of this document.

V. PHYSICAL ASSESSMENT

A physical assessment of the applicant's discharge is necessary to determine the initial dilution that will be achieved, the zone of initial dilution (ZID), and the farfield transport and dispersion of the effluent.

Municipal wastewater effluent discharged into the ocean through submerged outfalls creates a buoyant plume that rises quickly toward the surface, entraining significant amounts of ambient saline water. The momentum and buoyancy of the effluent relative to seawater are primarily responsible for entrainment of seawater, although in some circumstances ambient currents and turbulence also contribute to initial dilution.

One consequence of the entrainment process is that the density of the rising plume becomes greater and approaches that of the ambient waters along its trajectory. If a sufficient ambient vertical density gradient or a stratification zone (like a pycnocline) is present, the plume can spread horizontally at a level of neutral buoyancy below the sea surface. If a sufficient density gradient is not present, the diluted wastewater plume reaches the surface and flows horizontally.

INITIAL DILUTION

Data Requirements

Characteristics of the discharge and physical environmental conditions at the discharge site are needed to calculate initial dilution. Information is required for the period(s) of maximum stratification and other critical periods. A diagram or verbal description of the diffuser length and diameter, port orientation, and arrangement with respect to the seabed and to other ports will be used by EPA to assess the adequacy of the calculations and the adequacy of the design. For multiport diffusers, the design flow of each port is requested, as unequal flow may influence the actual dilution achieved. It is also helpful to have information for the period(s) of minimum stratification. It is not necessary for the applicant to calculate the initial dilution for each port but only for that segment of the diffuser with the highest flow rate per unit diffuser length or for the port with the highest flow rate.

Effluent flow data are required for the computations. Historical data should be used to determine the minimum, average dry-weather, average wet-weather, annual average, and maximum flows.

Since initial dilution calculations can be strongly dependent on the vertical gradient of density relative to the density of the wastewater, larger applicants will need to evaluate a substantial amount of data from both the discharge site and nearby areas having similar environmental conditions before selecting a worst-case density profile. Since ambient currents may affect the initial dilution achieved, a modest amount of current (the lowest 10 percentile) can be used in predicting initial dilution.

Initial dilution is the flux-averaged dilution (averaged over the cross-sectional area of the plume) achieved during the period when dilution is primarily a result of plume entrainment. It is characterized by a time scale on the order of minutes. With proper location and design, marine outfalls can achieve initial dilution values of about 100 to 1 or better before the plume begins a transition from essentially vertical flow to an essentially horizontal flow dominated by ambient oceanographic conditions. For the purpose of this evaluation process, "dilution" is defined as the ratio of the total volume of a sample (ambient water plus wastewater) to the volume of wastewater in that sample. A dilution of 100 to 1, therefore, is a mixture composed of 99 parts of ambient water and 1 part of wastewater.

Adequate initial dilution is necessary to assure compliance with water quality standards. A number of factors influence the degree of initial dilution which will be achieved. These factors include:

Discharge depth
Flow rates
Density of effluent
Density gradients in the receiving water

Ambient current speed and direction
Diffuser characteristics
  Port sizes
  Port spacing
  Port orientation

There are a number of methods and models available to calculate the initial dilution to be expected for different oceanographic and diffuser conditions. This section describes several methods of computing initial dilution.

Computer Models

Several mathematical models are available from EPA which are appropriate for different oceanographic and diffuser conditions. A summary of the characteristics of these models is presented in Table V-1 and a brief description of them is provided here:

- PLUME - Analyzes a single, positively buoyant plume in an arbitrarily stratified stagnant environment.

- OUTPLM - Analyzes a single, positively buoyant plume in an arbitrarily stratified flowing environment.

- DKHPLM - Analyzes a multiport, positively buoyant plume in a linearly stratified flowing receiving water.

- MERGE - Analyzes either positively or negatively buoyant discharges. The model analyzes a plume element through the history of its trajectory and dilution, accounting for the effects of adjacent plume interference in a receiving water with arbitrary vertical density and current variation.

- LINE - Treats discharges as a line source accounting for adjacent plume interference. The model is capable of analyzing positively buoyant discharges in an arbitrarily stratified receiving water with a current flowing parallel or perpendicular to the diffuser.

TABLE V-1. SUMMARY OF PLUME MODEL CHARACTERISTICS

Model Name	Current Speed	Current Direction Θ [a]	Port Type	Density Profile Type
PLUME	no		single	arbitrary
OUTPLM	yes	90°	single	arbitrary
DKHPLM	yes	$70^\circ < \Theta < 110^\circ$	multiple	linear
MERGE	yes	90°	multiple	arbitrary
LINE	yes	$0 \leq \Theta \leq 180^\circ$	line	arbitrary

[a] A current flowing perpendicular to the diffuser axis has current direction $\Theta = 90^\circ$. The widest range of possible angles is 0 to 180°.

The first three of these models are described in detail by Teeter and Baumgartner (1979) and are adequate for most situations. The model MERGE is a generalization of OUTPLM. The model LINE is a generalization of Roberts (1979). Neither MERGE nor LINE has been published in the open literature but both have been used in the evaluation of section 301(h) applications. All of these models are available from the EPA. Applicants are not required to use any of the models listed in Table V-1. If other methods are used, however, the application should include a detailed description of the method(s) employed and demonstrate that the method(s) provides reasonable estimates of initial dilution.

Other methods to determine initial dilution may include in situ observations. However, if in situ observations are used, the applicant should demonstrate that they represent the critical dilutions, not merely a typical dilution. In addition, there are a number of other mathematical models available in the published literature which can be adapted for estimating initial dilution. References which describe several of these models are: Abraham (1963, 1971); Baumgartner and Trent (1970); Baumgartner et al. (1971); Briggs (1969); Brooks (1973); Cederwall (1971); Davis (1975); Davis and Shirazi (1978); Fan (1967); Hirst (1971a, b); Kannberg and Davis (1976); Koh and Fan (1970); Morton (1959); Morton et al. (1956); Priestley and Ball (1955); Rouse et al. (1952); Sotil (1971); Teeter and Baumgartner (1979); and Winiarski and Frick (1976).

ZONE OF INITIAL DILUTION (ZID)

The ZID is the region of initial mixing surrounding or adjacent to the end of the outfall pipe or diffuser ports and includes the underlying seabed. The ZID describes an area in which inhabitants, including the benthos, may be chronically exposed to concentrations of pollutants in excess of water quality standards or at least to concentrations greater than those predicted for the critical conditions described above. The ZID does not attempt to describe the area bounding the entire mixing process for all conditions, or the total area impacted by the sedimentation of settleable material.

In general, the ZID can be considered to include that bottom area within a distance equal to the water depth from any point of the diffuser and the water column above that area. Figure V-1 shows several examples for different diffuser configurations and corresponding ZID dimensions.

DISPERSION AND TRANSPORT

A general description of the ambient currents expected within the influence of the diffuser site is required by EPA. Since this description is primarily of use in the determination of where the effluent wastefield is likely to be transported during several days' time, the response to this subsection should be of sufficient detail for this purpose. In a region where currents are predominantly tidal in nature, current persistence and the mean current speed and its variance, with respect to the primary direction(s) of water flow, should be given. If the currents have large components unrelated to tidal influences (e.g., wind induced currents), then a more detailed analysis should be performed. The mean, variance, and direction of the tidal component should be determined, as well as a synopsis of the nontidal current speed, direction, and persistence. Depth variations in currents are important at depths where the effluent wastefield is trapped.

The basis for the current estimates should be provided. Acceptable sources of information are site-specific measurements and/or published measurements or predictions. The Tidal Current Tables published annually by the U.S. Department of Commerce [see USDOC (1979a, b)] provide tidal current information for a large number of locations. Information from other published documents is usable if the documents are available to EPA on request.

Expected or measured dilutions at significant shoreline stations should be included. Section VI of this document provides further guidance on computing farfield dilutions for water quality parameters.

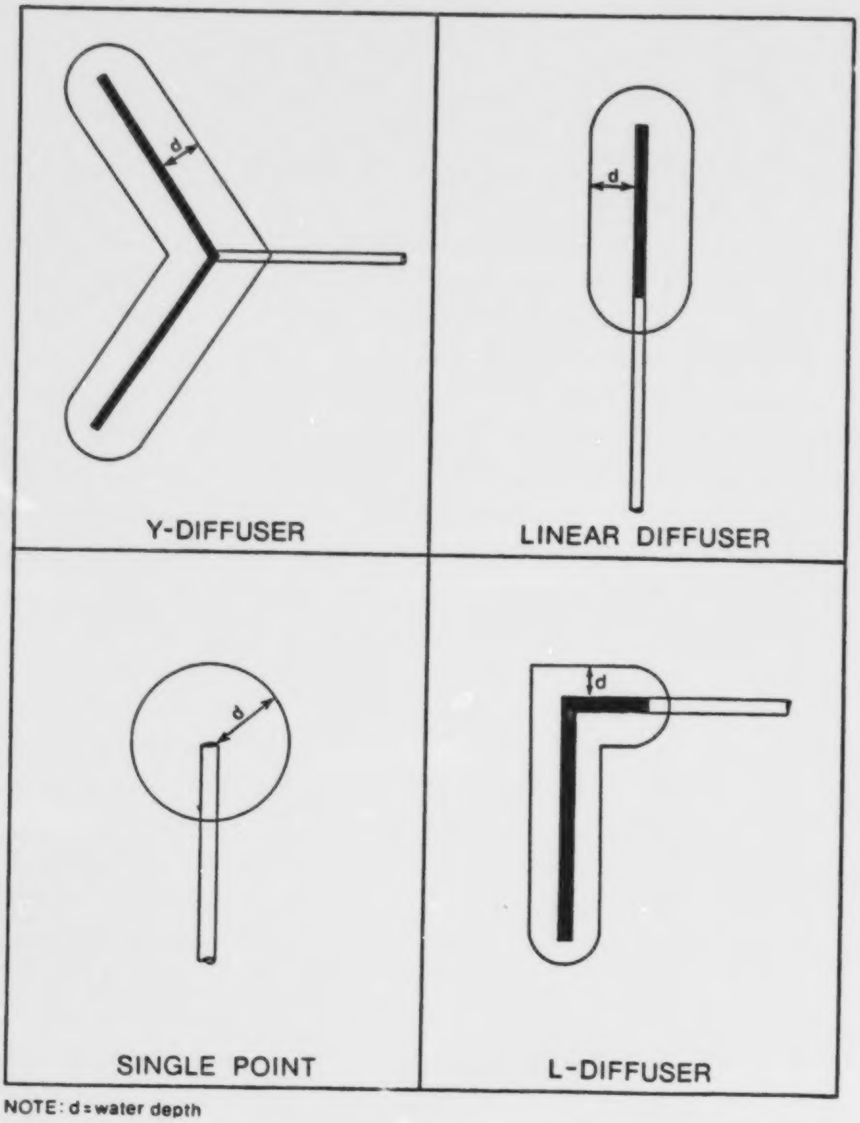

d
Y-DIFFUSER
d
LINEAR DIFFUSER
d
SINGLE POINT
d
L-DIFFUSER
NOTE: d = water depth

Figure V-1. Diffuser types and corresponding ZID configurations

VI. WATER QUALITY ASSESSMENT

A water quality assessment is necessary to demonstrate that water quality standards will be met and that water quality conditions will be adequate to assure the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife and allow recreational activities in and on the water. This section provides guidance on appropriate methods to assess the effects of the discharge on water quality conditions. As the methods used to determine compliance with water quality standards vary, the applicant may wish to consult with appropriate state personnel.

AMBIENT WATER QUALITY

Ambient water quality data are needed to characterize the receiving water and provide a basis for computing the effects of the discharge. The parameters needed for water quality analyses include dissolved oxygen, pH, suspended solids, light transmittance or other surrogates for suspended solids, and coliform bacteria. Salinity and temperature data are needed to characterize the receiving water and to determine appropriate values for decay constants and other coefficients (typical values are provided herein).

Sources of background water quality data, in addition to the applicant's own data, include water quality management planning studies, receiving water studies conducted by state agencies or private groups, and data from other 301(h) applicants. In some areas large regional studies may provide water quality data. Examples are the Southern California Coastal Water Research Project, the Puget Sound Interim Studies done for the Municipality of Metropolitan Seattle, Oceanographic Baseline Data for the Formulation of Marine Waste Disposal Alternatives for Puerto Rico, the Water Quality Program for Oahu, and studies in Chesapeake Bay. Other information may be available from local universities and studies conducted for nearby industrial outfalls or power plant discharges.

Depth profiles of water quality parameters should be provided at several control stations for determining ambient water quality (i.e., unaffected by applicant's discharge). EPA requires that profiles at the control stations be measured during the season(s) of maximum stratification and other potentially critical periods of discharge characteristics, water quality, biological seasons, or oceanographic conditions. In shallow water [10 m (33 ft) or less], measurements should be taken at a minimum of 1 m (3.3 ft) below the water surface, at 1 m (3.3 ft) above the bottom, and at mid-depth. In deeper waters, measurements should be made at a minimum of 3-m (10-ft) intervals. An example of the information needed is shown in Table VI-1. All data sets should identify the exact location of the stations on a map, the depth at which the measurements were taken, the date of the survey, whether effluent was discharging from the outfall or not, and any unusual conditions such as storms or onshore currents. The actual data profiles should be included in the application. In some states, coliform data are also required at the surf zone and nearshore locations.

SUSPENDED SOLIDS

Suspended solids in a wastefield can affect the light transmittance of the water column and can form benthic sediment deposits which decay and consume oxygen. Toxic constituents can also be adsorbed onto the sediment particles. Suspended solids can thus affect biota directly or because of the associated benthic oxygen demand or toxic constituents. Water quality standards relating to suspended solids may be expressed as a general prohibition against objectionable sludge or bottom deposits, a quantitative suspended solids or settleable solids concentration, or as a surrogate parameter. Surrogates include percent light transmittance, turbidity, secchi disc depth, and extinction coefficient. Because the effluent suspended solids concentrations are generally available and the concentration at the completion of initial dilution is easily computed, the predicted suspended solids concentration may be used as an indicator of whether the discharge causes a significant change from background concentrations.

TABLE VI-1. EXAMPLE OF AMBIENT WATER QUALITY DATA NEEDED

Station Name:Location

Date:Time

Depth, m	DO, mg/l	Temp, °C	Salinity, ppt	pH	Suspended Solids, mg/l
1					
4					
7					
10					
13					
16					
19					
22					
25					

Weather Conditions:
Wind Speed and Direction:
Unusual Oceanographic Conditions:
Predominant Current Direction:
Effluent Discharging at Time of Sampling
    Flow, m^3/sec:
    BOD_5, mg/l:
    Suspended Solids, mg/l:

Suspended Solids at Completion of Initial Dilution

The concentration at the completion of initial dilution should be calculated using the following equation:

$$SS_f = SS_a + \frac{SS_e - SS_a}{S_a} \qquad \text{VI-1}$$

where:

SS_f = suspended solids concentration at completion of initial dilution, mg/l

SS_a = ambient suspended solids concentration, mg/l

SS_e = effluent suspended solids concentration, mg/l

S_a = initial dilution (flux-averaged).

The maximum change, ΔS, due to the effluent can be computed as follows:

$$\Delta S = SS_e/S_a \qquad \text{VI-2}$$

where the terms are as defined above. Equation VI-2 is appropriate as long as the effluent suspended solids concentration is much greater than the ambient concentration. During spring runoff in some estuaries, the ambient suspended solids concentration may exceed the effluent concentration. In these cases, the final suspended solids concentration will be below the ambient concentration.

EPA requires data for period(s) of maximum stratification and for other periods when discharge characteristics, oceanographic conditions, water quality or biological seasons indicate more critical situations exist. The critical period is generally when water quality standards are most likely to be violated. If the standard is expressed as a maximum numerical limit, the critical period would be when the ambient concentrations are highest and the initial dilution is low. If the standard is expressed as a numerical difference from ambient, the critical period would be when effluent concentrations are high and initial dilution low. When the standard is expressed as a percent difference from ambient, the critical period could occur when ambient concentrations are low.

Because effluent suspended solids concentrations can vary with discharge flow rate, the concentration at the completion of initial dilution should be computed for the minimum, average dry and wet weather, and maximum flow rates using the associated suspended solids concentration. The range and average effluent concentrations by month should be provided in the application. This information should be available from operating records.

The selection of an appropriate ambient suspended solids concentration may be difficult due to a general lack of data. A common problem for coastal sites is that measurements may be available only at the mouths of large rivers. Concentrations are often higher here than further offshore due to the solids contribution from runoff. Selected values of ambient suspended solids concentrations are shown in Table VI-2. Ambient suspended solids data should be obtained at control stations and at the ZID boundary of the existing discharges. Data should be collected at several depths so the average concentration over the height of rise of the plume can be calculated. This value should be used in Equation VI-1.

Compliance with the water quality standard can be determined directly if the standard is expressed in the form of suspended solids concentrations. If only a general standard exists, the maximum increase due to the effluent should be computed. If the increase is less than 10 percent, then no significant effect in the water column is likely. However, seabed deposition could still be significant depending on the mass emission rate of suspended solids and ambient currents at the discharge site and thus should be evaluated.

The water quality standards may also specify limitations on the level of suspended solids removal. For example, California has a requirement that 75 percent of the solids entering publicly owned treatment works (POTW) must be removed. Compliance with this standard can be determined by estimating the average removal efficiency for each month based on the average monthly influent and effluent suspended solids concentrations. The removal

TABLE VI-2. SELECTED AMBIENT SUSPENDED SOLIDS CONCENTRATIONS

Water Body	Suspended Solids Concentration, mg/l
Cook Inlet, AK	250-1,280
Southern California Bight	0.7-60
Pacific Ocean near San Francisco, CA	1-33
Broad Sound, MA	18.6-25.2
Massachusetts Bay near South Essex	1.2-30.5
New Bedford Harbor, MA	0.4-6.1
East River, NY	6.0-25.6
Ponce, PR (near shore)	13.5
Puget Sound, WA	0.5-2.0
Outer Commencement Bay, Tacoma, WA	33-51
Commencement Bay near Puyallup River, WA	23-136
Tacoma Narrows, WA	33-63

Note: Data are from 301(h) applications.

efficiency should be equal to or greater than the required percentage in all months. The applicant should include the monthly average influent and effluent suspended solids concentrations along with the computed removal efficiencies.

SUSPENDED SOLIDS DEPOSITION

The applicant is to predict the seabed accumulation resulting from the discharge of suspended solids into the receiving water. A simplified approach to accomplish this task is presented here. Although more sophisticated approaches exist, they usually require more extensive data and the use of a computer.

The approach described here considers the processes of sediment deposition, decay of organic materials, and resuspension. However, prediction of seabed accumulation is based only on the processes of deposition and decay. Since resuspension is not easily evaluated using simplified approaches, the analyses described in this chapter consider resuspension separately and in a more qualitative manner based on measured current speeds near the bottom in the vicinity of the discharge.

Data Requirements

To predict seabed deposition rates of suspended solids, the following information is required:

- Suspended solids mass emission rate
- Current speed and direction
- Height of rise of the plume
- Suspended solids settling velocity distribution.

The mass emission rate, in kg/day, is:

$$M = 86.4(S)(Q) \qquad \text{VI-3}$$

where:

S = suspended solids concentration, mg/l

Q = volumetric flow rate, m^3/sec.

It is suggested that the applicant develop estimates of the suspended solids mass emission rate for the season (90-day period) critical for seabed deposition and for a yearly period. If the applicant anticipates the mass emission rate will increase during the permit term, the mass emission rate at the end of the permit term should be used.

Current speed data are needed to determine how far from the outfall the sediments will travel before accumulating on the bottom. Consequently, depth-averaged values are best, if available. Otherwise, current speeds near mid-depth may be sufficient. Current data needed for the assessment are:

- Average value upcoast, when the current is upcoast
- Average value downcoast, when the current is downcoast
- Average value onshore, when the current is onshore
- Average value offshore, when the current is offshore.

If no current data are available, values of 5 cm/sec for longshore transport and 3 cm/sec for onshore-offshore transport have been found to be reasonable values.

The plume's trapping levels representative of the critical 90-day period and representative of an annual cycle are needed. The applicant should use density profiles, effluent volumetric flow rates, and ambient currents characteristic of these time periods. Extreme values should not be used.

If the applicant has not determined a suspended solids settling velocity distribution, the following can be used (where V_s is settling velocity) based on data from other section 301(h) applications:

Primary or Advanced Primary	Raw
5 percent have $V_s \geq 0.1$ cm/sec	5 percent have $V_s \geq 1.0$ cm/sec
20 percent have $V_s \geq 0.01$ cm/sec	20 percent have $V_s \geq 0.5$ cm/sec
30 percent have $V_s \geq 0.006$ cm/sec	40 percent have $V_s \geq 0.1$ cm/sec
50 percent have $V_s \geq 0.001$ cm/sec	60 percent have $V_s \geq 0.01$ cm/sec
	85 percent have $V_s \geq 0.001$ cm/sec.

The remaining solids settle so slowly that they are assumed to remain suspended in the water column indefinitely (i.e., they act as colloids). Consequently, 50 percent of the suspended solids in a treated effluent and 85 percent of those in a raw sewage discharge are assumed to be settleable in the ambient environment.

Prediction of Deposition

Although a portion of the settled solids is inert, primary concern is with the organic fraction of the settled solids. For purposes of this evaluation, composition of the waste discharge can be assumed to be:

- 80 percent organic and 20 percent inorganic, for primary or advanced primary effluent

- 50 percent organic and 50 percent inorganic, for raw sewage.

Accumulation should be predicted for the critical 90-day period when seabed deposition is likely to be highest and for steady-state conditions where average annual values are used. The results should be presented in graphical form, as shown in Figure VI-1. The applicant will have to exercise some judgment in developing the contours, especially in accounting for rapid depth changes offshore. The sediment contours should be expressed in units of g/m^2 and not as an accumulation depth. Supporting tabulations should be submitted with the application.

To begin computations, the applicant can create a table similar to Table VI-3. The table shows the amount of organic solids which settle within each settling velocity group, and the maximum distance from the

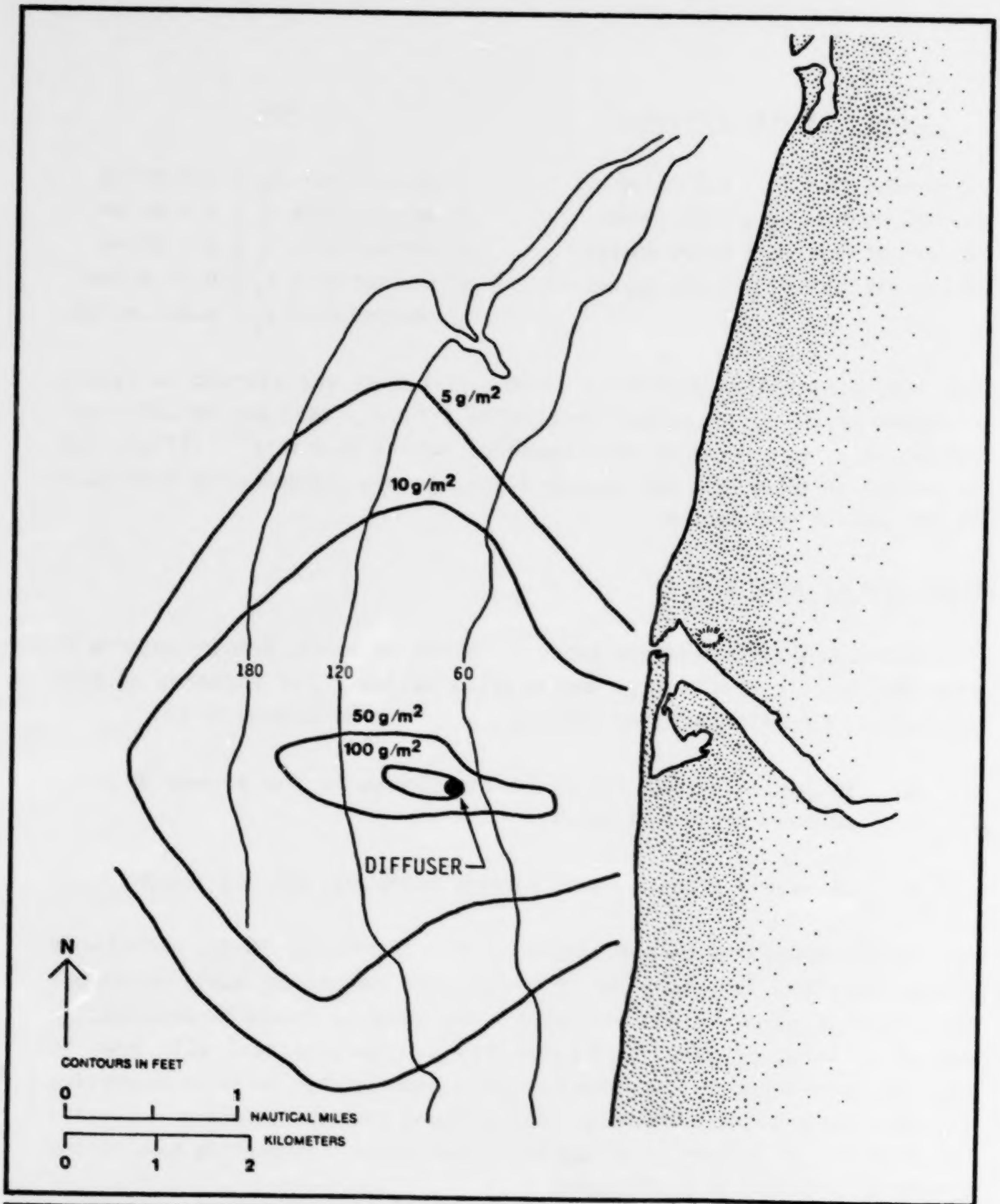

5 g/m2
10 g/m2
180
120
60
50 g/m2
100 g/m2
DIFFUSER
N
CONTOURS IN FEET
0
1
NAUTICAL MILES
KILOMETERS
0
1
2

Figure VI-1. Example of predicted steady-state sediment accumulation around a marine outfall.

TABLE VI-3. EXAMPLE TABULATIONS OF SETTLEABLE ORGANIC COMPONENT BY GROUP AND MAXIMUM SETTLING DISTANCE BY GROUP

Mass Emission Rate = M_T

$$\text{Organic Component} = \text{Mo} = \begin{cases} 0.8\ M_T, \text{ for primary effluent} \\ 0.5\ M_T, \text{ for raw effluent} \end{cases}$$

PRIMARY EFFLUENT

Percent by Settling Velocity Group	Organic Component by Group	Maximum Settling Distance from Outfall[a]			
		Upcoast	Downcoast	Onshore	Offshore
5 (V_s = 0.1 cm/sec)	0.04 M_T	D_1	D_2	D_3	D_4
15 (V_s = 0.01 cm/sec)	0.12 M_T	D_5	D_6	D_7	D_8
10 (V_s = 0.006 cm/sec)	0.08 M_T	D_9	D_{10}	D_{11}	D_{12}
20 (V_s = 0.001 cm/sec	0.16 M_T	D_{13}	D_{14}	D_{15}	D_{16}
	Sum = 0.40 M_T				

RAW SEWAGE

Percent by Settling Velocity Group	Organic Component by Group	Maximum Settling Distance from Outfall[a]			
		Upcoast	Downcoast	Onshore	Offshore
10 (V_s = 1.0 cm/sec)	0.05 M_T	R_1	R_2	R_3	R_4
10 (V_s = 0.5 cm/sec)	0.05 M_T	R_5	R_6	R_7	R_8
20 (V_s = 0.1 cm/sec)	0.10 M_T	R_9	R_{10}	R_{11}	R_{12}
20 (V_s = 0.01 cm/sec)	0.10 M_T	R_{13}	R_{14}	R_{15}	R_{16}
25 (V_s = 0.001 cm/sec)	0.125 M_T	R_{17}	R_{18}	R_{19}	R_{20}
	Sum = 0.425 M_T				

[a] The distance D (or R) is calculated as: $D \text{ (or R)} = \frac{V_a H_T}{V_s}$

where

V_a = ambient velocity = 5 cm/sec upcoast and downcoast (default) and 3 cm/sec on coast and off coast (default)

H_T = average trapping level of plume, measured above bottom

V_s = appropriate settling velocity by group for primary or raw discharges

If the bottom slope is 5 percent or greater, D should be calculated as follows:

$$D = \frac{H_T}{S + \frac{V_s}{V_a}}$$

where

S = slope, m/m, positive if onshore, negative if offshore.

outfall that each group settles. If the applicant has current data for more than four quadrants, those data can be used. The maximum settling distances for each group in each direction are calculated using the formula shown in the footnote of Table VI-3.

Using a sufficiently detailed map (e.g., a NOAA bathymetric chart) each point D_1 through D_{16}, or R_1 through R_{20}, can be plotted with the center of the diffuser as the reference point. Depositional contours are formed by the four points $D_1D_2D_3D_4$, $R_1R_2R_3R_4$, etc. The applicant should join these points by smooth lines, so the contours are elliptically shaped. If the applicant has current data at 60^o or 30^o intervals, instead of the 90^o intervals used here, then the contours could be created more accurately.

The deposition rates corresponding to each contour are found as follows. First, predict the deposition rate within each contour due to each individual settling velocity group, as shown in Table VI-4. This quantity is simply M_i/A_i, or the group deposition rate divided by the area within the contour. The area within any contour is a function of the four points D_1, D_2, D_3, and D_4, for example, and is denoted in the table by $f(D_1D_2D_3D_4)$. A planimeter is probably the most accurate method of finding the area. Once the deposition rates by group have been found, then the total deposition rate is the sum of all contributing deposition rates. For example, the innermost contour receives contributions from all groups, while the outermost contour receives a contribution only from one group.

So far, only organic deposition rates (in units of $g/m^2/yr$) have been predicted. Now the accumulation of the organic material (S_i) can be predicted by including decay as follows:

$$S_i\ (g/m^2) = \begin{cases} \dfrac{f_i}{k_d}\text{, at steady state} \\ \\ \dfrac{f_i}{k_d}\ [1 - \exp(-90\ k_d)]\text{, for 90 days} \end{cases} \qquad \text{VI-4}$$

TABLE VI-4. EXAMPLE TABULATIONS OF DEPOSITION RATES AND ACCUMULATION RATES BY CONTOUR

PRIMARY EFFLUENT

Organic Mass Component by Group	Bottom Area	Mass Deposition Rate, by Group	Total Organic Deposition Rate within Area ($g/m^2/yr$)	Accumulation (g/m^2) Steady-state	Accumulation (g/m^2) 90 day
$0.04\ M_T = M_1$	$A_1 = f(D_1D_2D_3D_4)$	M_1/A_1	$M_1/A_1+M_2/A_2+M_3/A_3+M_4/A_4 = f_1$	↑	↑
$0.12\ M_T = M_2$	$A_2 = f(D_5D_6D_7D_8)$	M_2/A_2	$M_2/A_2+M_3/A_3+M_4/A_4 = f_2$		
$0.08\ M_T = M_3$	$A_3 = f(D_9D_{10}D_{11}D_{12})$	M_3/A_3	$M_3/A_3+M_4/A_4 = f_3$	$\frac{f_i}{k_d}$	$\frac{f_i}{k_d}[1-\exp(-90k_d)]$
$0.16\ M_T = M_4$	$A_4 = f(D_{13}D_{14}D_{15}D_{16})$	M_4/A_4	$M_4/A_4 = f_4$	↓	

RAW SEWAGE

Organic Mass Component by Group	Bottom Area	Mass Deposition Rate, by Group	Total Organic Deposition Rate within Area ($g/m^2/yr$)	Accumulation (g/m^2) Steady-state	Accumulation (g/m^2) 90 day
$0.05\ M_T = M_1$	$A_1 = f(R_1R_2R_3R_4)$	M_1/A_1	$M_1/A_1+M_2/A_2+M_3/A_3+M_4/A_4+M_5/A_5 = f_1$	↑	↑
$0.05\ M_T = M_2$	$A_2 = f(R_5R_6R_7R_8)$	M_2/A_2	$M_2/A_2+M_3/A_3+M_4/A_4+M_5/A_5 = f_2$		
$0.10\ M_T = M_3$	$A_3 = f(R_9R_{10}R_{11}R_{12})$	M_3/A_3	$M_3/A_3+M_4/A_4+M_5/A_5 = f_3$	$\frac{f_i}{k_d}$	$\frac{f_i}{k_d}[1-\exp(-90k_d)]$
$0.10\ M_T = M_4$	$A_4 = f(R_{13}R_{14}R_{15}R_{16})$	M_4/A_4	$M_4/A_4+M_5/A_5 = f_4$		
$0.125\ M_T = M_5$	$A_5 = f(R_{17}R_{18}R_{19}R_{20})$	M_5/A_5	$M_5/A_5 = f_5$	↓	↓

Note: Units of f_i are $g/m^2/day$.

The f_i are the deposition rates in units of $g/m^2/day$, as contrasted to the units of $g/m^2/yr$ in Table VI-4. The decay rate constant, k_d, has a typical value of 0.01/day.

If the organic deposition rate for annual conditions is 100 $g/m^2/yr$, for example, the steady state accumulation is:

$$100\ g/m^2/yr \times \frac{1\ yr}{365\ days} \times \frac{1}{0.01/day} = 27\ g/m^2 \qquad \text{VI-5}$$

If the organic deposition rate for the critical 90-day period is 300 $g/m^2/yr$, the 90-day accumulation is:

$$300\ g/m^2/yr \times \frac{1\ yr}{365\ days} \times \frac{1}{0.01/day} \times [1 - \exp(-90 \times 0.01)] = 49\ g/m^2 \qquad \text{VI-6}$$

This example shows that the 90-day accumulation is computed using different data than for the steady-state case. Consequently, Tables VI-3 and VI-4 should each be completed twice. Also the accumulation over a critical 90-day period can exceed the steady-state accumulation. This is caused by short-term deposition rates which are considerably higher than the long-term average. In the example, the maximum 90-day deposition rate of 300 $g/m^2/yr$ would eventually decrease to values below 100 $g/m^2/yr$, so that on a yearly basis the deposition rate is 100 $g/m^2/yr$.

Resuspension of Deposited Sediments

Ambient current speeds in the vicinity of the discharge might be sufficient to prevent effluent suspended solids from settling and to resuspend those which have settled. However, it is expected that at most outfall locations some settling will occur during periods of low ambient current speeds. Table VI-5 provides criteria for assessing whether or not resuspension is likely.

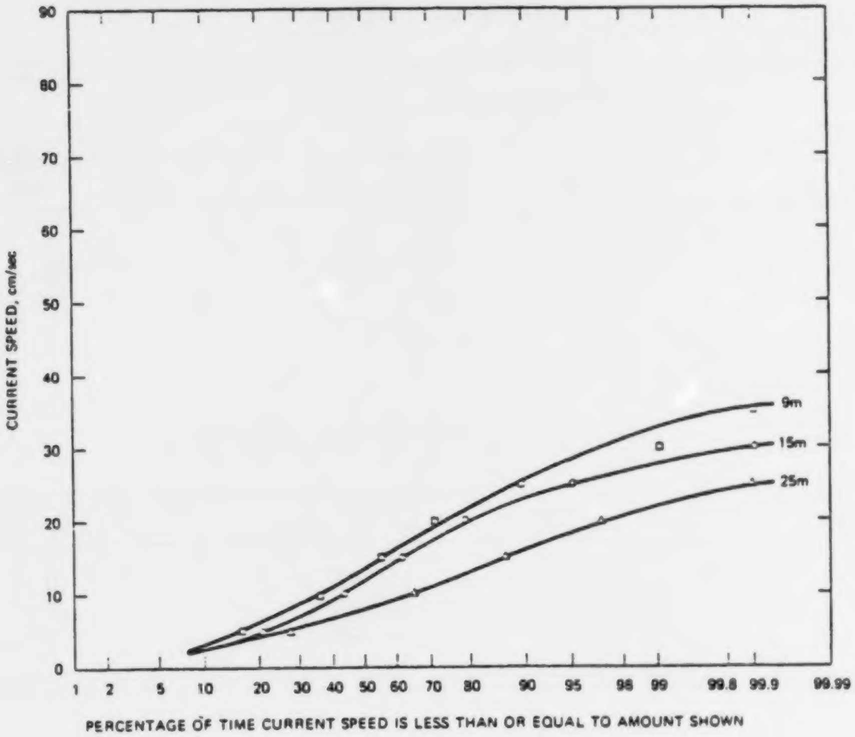
TABLE VI-5. BOTTOM CURRENT SPEEDS TO INDUCE RESUSPENSION

	Untreated Effluent	Primary Effluent
Resuspension unlikely	0-6 cm/sec	0-6 cm/sec
Resuspension possible	6-30 cm/sec	6-20 cm/sec
Resuspension probable	30 cm/sec	20 cm/sec

If the evidence indicates resuspension is significant, then current speed data collected in the bottom 2 m (6.6 ft) of the water column should be submitted. Although speeds are more likely to be higher near the seabed in shallow water than in deep water, the applicant should not conclude that it is more advantageous to locate the diffuser in shallow water. Initial dilutions from shallow water discharges will be less and the potential for adverse effects on nearshore biological communities and recreational activities greater.

The applicant should analyze current data to assess the significance of sediment resuspension. If the applicant has available an extended record of current speeds, a convenient way of presenting the data is by a cumulative frequency distribution as shown in Figure VI-2. The three curves represent current speeds at three depths. This method of presentation clearly reveals the percent of time current speeds are sufficient to resuspend sediments. It also puts into better perspective the occasional very high or very low current speeds which might be recorded. If the applicant has data for different months of the year, the data for each month should be presented separately so that seasonal variability can be distinguished. In addition to plotting the data, the applicant might choose to tabulate the data (as shown by an example in Table VI-6) to show the distribution of current speeds in each interval of interest. The example in Table VI-6 illustrates the possibly large variability by months (e.g., compare May to January). In January, for example, current speeds of 20 cm/sec were exceeded 45 percent of the time, indicating that suspended solids in primary effluent would probably be resuspended a large portion of the time, and seabed accumulation would be minimal during this time of year. In contrast, discharge of untreated effluent during the month of May would probably result in sediment accumulation since current speeds never exceeded 30 cm/sec.

The applicant should understand that even if resuspension occurs a certain fraction of time, seabed deposition does not completely cease. Velocities required to keep the sediments in suspension generally do not persist indefinitely. Consequently the effluent-related sediments tend to be reworked and redistributed, but not completely dispersed. Therefore, the applicant is encouraged to predict seabed accumulation in the absence of resuspension as an upper limit estimate of seabed accumulation.



REFERENCE: FIGURE III-6, SANTA CRUZ 301(h) APPLICATION, 1979.

Figure VI-2. Example cumulative frequency distribution of current speed.

TABLE VI-6. EXAMPLE SUMMARY OF CURRENT METER DATA BY SPEED INTERVAL

Intervals for Primary Discharges

Time Period	Frequency of Occurrence (Percent) 0-6 cm/sec	6-20 cm/sec	>20 cm/sec
May	30	65	5
January	5	50	45
Annual	15	65	20

Intervals for Untreated Discharges

Time Period	Frequency of Occurrence (Percent) 0-6 cm/sec	6-30 cm/sec	>30 cm/sec
May	30	70	0
January	5	80	15
Annual	15	80	5

DISSOLVED OXYGEN

Dissolved oxygen is an important determinant of the water quality of a receiving water body and thus of the uses of the water body. The discharge of BOD in municipal wastewater exerts a demand on the oxygen resource of the water body. In some well-flushed coastal environments, this exertion might not be significant. However, analyses are to be performed to show compliance with dissolved oxygen water quality standards. At the present time, all states have standards for dissolved oxygen rather than for BOD. Because BOD is chemically related to dissolved oxygen, dissolved oxygen is an acceptable surrogate for BOD for the purposes of the 301(h) regulations.

The discharged effluent can decrease the dissolved oxygen resource in the water column at different depths and after varying travel times. The analyses are to include depletion after initial mixing of the waste plume, depletion due to BOD exertion in the water column as the wastefield is dispersed, depletion near the bottom due to the steady demand of effluent-related sediments, and depletion due to the resuspension of effluent-related sediments as indicated in Figure VI-3. Methods for predicting the effect of the effluent for each of these processes are discussed in the following sections. The selection of critical cases and minimum data requirements is explained.

Dissolved Oxygen after Initial Dilution

When wastewater is discharged through a single port or a diffuser, the effluent forms a buoyant plume which entrains ambient water as it rises. Because the initial dilution process occurs rapidly (i.e., on the order of minutes), BOD exertion (a relatively slow process) is negligible during this period. However, an immediate dissolved oxygen demand (IDOD), which represents the oxygen demand of reduced substances which are rapidly oxidized (e.g., sulfides to sulfates), might not be negligible. The dissolved oxygen concentration following initial dilution can be predicted using the following expression:

$$DO_f = DO_a + (DO_e - IDOD - DO_a)/S_a \qquad \text{VI-7}$$

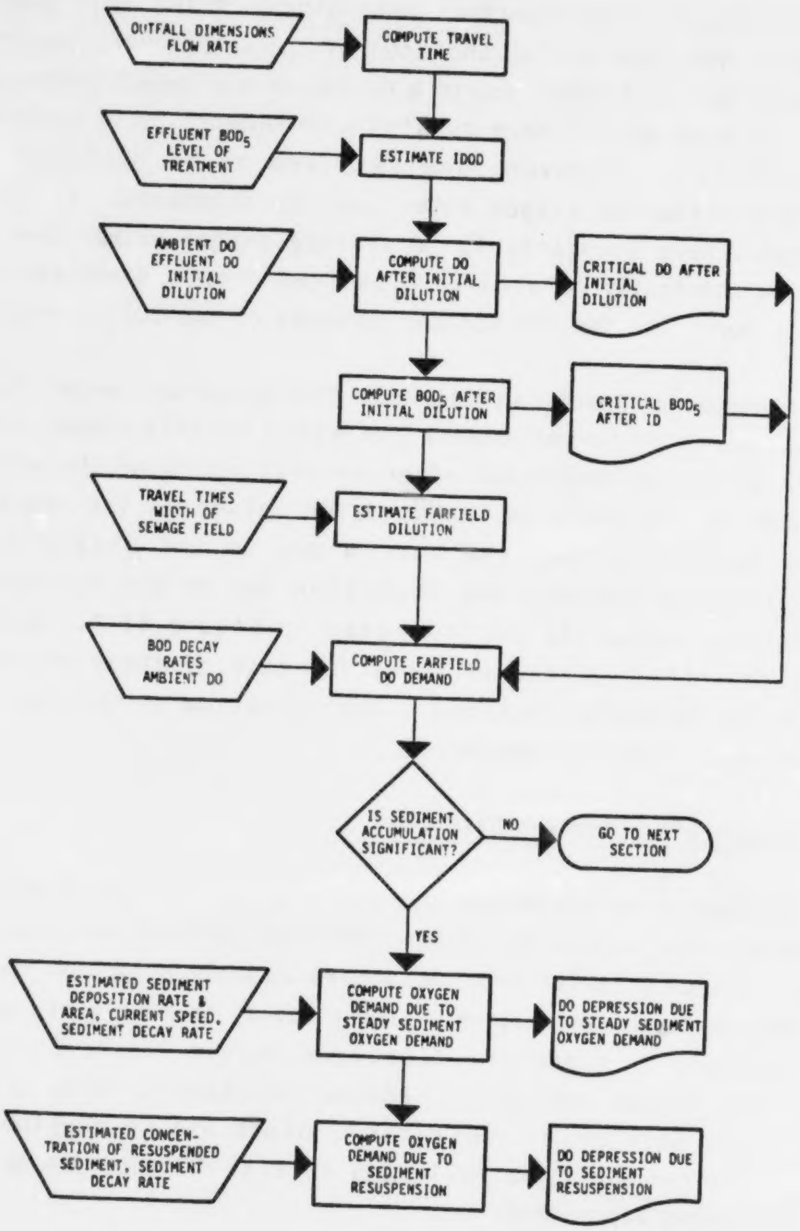

OUTFALL DIMENSIONS
FLOW RATE
COMPUTE TRAVEL TIME
EFFLUENT BOD_5
LEVEL OF TREATMENT
ESTIMATE IDOD
AMBIENT DO
EFFLUENT DO
INITIAL DILUTION
COMPUTE DO AFTER INITIAL DILUTION
CRITICAL DO AFTER INITIAL DILUTION
COMPUTE BOD_5 AFTER INITIAL DILUTION
CRITICAL BOD_5 AFTER ID
TRAVEL TIMES
WIDTH OF SEWAGE FIELD
ESTIMATE FARFIELD DILUTION
BOD DECAY RATES
AMBIENT DO
COMPUTE FARFIELD DO DEMAND
IS SEDIMENT ACCUMULATION SIGNIFICANT?
NO
GO TO NEXT SECTION
YES
ESTIMATED SEDIMENT DEPOSITION RATE & AREA, CURRENT SPEED, SEDIMENT DECAY RATE
COMPUTE OXYGEN DEMAND DUE TO STEADY SEDIMENT OXYGEN DEMAND
DO DEPRESSION DUE TO STEADY SEDIMENT OXYGEN DEMAND
ESTIMATED CONCENTRATION OF RESUSPENDED SEDIMENT, SEDIMENT DECAY RATE
COMPUTE OXYGEN DEMAND DUE TO SEDIMENT RESUSPENSION
DO DEPRESSION DUE TO SEDIMENT RESUSPENSION

Figure VI-3. Summary of dissolved oxygen analyses.

where:

DO_f = final dissolved oxygen concentration of receiving water at the plume's trapping level, mg/l
DO_a = ambient dissolved oxygen concentration averaged from the diffuser port depth to the trapping level, mg/l
DO_e = dissolved oxygen of effluent, mg/l
IDOD = immediate dissolved oxygen demand, mg/l
S_a = initial dilution (flux-averaged).

The applicant should use the least favorable combination of values for effluent dissolved oxygen, IDOD, ambient dissolved oxygen, and initial dilution. The effluent dissolved oxygen concentration at the point of discharge from the treatment plant is often 0.0 mg/l. Because the critical case is desired, a concentration of 0.0 mg/l is a reasonable value. However, if data show that dissolved oxygen levels in the effluent are greater than 0.0 mg/l during the critical periods, then these data may be used.

The IDOD values typically vary from 0 to 10 mg/l, but can be higher depending on the level of treatment and presence of industrial flows. Table VI-7 can be used to select reasonable IDOD values. Alternatively, the IDOD can be measured as discussed subsequently. The significance of the effluent IDOD can be estimated from the tabulation presented below (calculated as $IDOD/S_a$):

Contribution of IDOD to DO_f (mg/l)

	Initial Dilution			
IDOD (mg/l)	10	30	50	100
1	0.1	0.03	0.02	0.01
2	0.2	0.07	0.04	0.02
5	0.5	0.17	0.1	0.05
10	1.0	0.33	0.2	0.10
20	2.0	0.67	0.4	0.20

TABLE VI-7. TYPICAL IDOD VALUES

Treatment Level	Effluent BOD_5, mg/l	Travel Time, min[a]	IDOD, mg/l
Untreated or less than primary	-	< 60	5
	-	60-200	10
	-	200-300	15
	-	> 300	20
Primary	50-100	0-100	2
	-	100-300	3
	-	> 300	4
	100-150	0-100	3
	-	100-300	4
	-	> 300	5
	150-200	0-100	5
	-	100-300	7
	-	> 300	8
Advanced primary	< 50	0-60	0
	-	> 60	1

[a] Travel time should include the total travel time from the treatment plant through the diffuser including any land portion of the outfall.

Note: Information compiled from 301(h) applications.

At high initial dilutions, the IDOD contribution is small. Thus, the expense of laboratory tests may be unwarranted. If IDOD is to be determined experimentally, the procedures in Standard Methods (APHA 1979) should be generally followed except that the dilution water should be sea water from the discharge site instead of distilled water, and the effluent sample should be incubated anaerobically for a length of time equal to the travel times from the plant through the diffuser for minimum, average, and maximum flow conditions. The effluent sample should be mixed with the dilution water after incubation. The dissolved oxygen of the effluent and dilution water should be measured separately after incubation and before mixing the samples. The dissolved oxygen of the mixture should be measured 15 minutes after preparation.

The IDOD is calculated using the following equation:

$$\mathrm{IDOD} = \frac{(\mathrm{DO_D})(P_D) + (S)(P_S) - \mathrm{DO_M}}{P_S} \qquad \text{VI-8}$$

where:

IDOD = immediate dissolved oxygen demand, mg/l
$\mathrm{DO_D}$ = dissolved oxygen of dilution water (sea water), mg/l
P_D = decimal fraction of dilution water used
S = dissolved oxygen of effluent after incubation, mg/l
P_S = decimal fraction of effluent used
$\mathrm{DO_M}$ = dissolved oxygen of mixture after 15 minutes, mg/l.

Several dilutions should be used, preferably close to the actual initial dilution, unless the difference between the initial and mixed concentrations is less than 0.1 mg/l. All data used in the above calculations, the incubation times, and the computed results for each test should be included in the application.

The lowest initial dilution (flux-averaged) should be used for the final dissolved oxygen calculation. Usually, this dilution will correspond to the maximum flow rate at the end of the permit term. Low initial dilutions can also occur at smaller effluent flow rates if stratification is severe enough. Typically, dilutions during periods of maximum stratification should be used for the final dissolved oxygen calculation.

The ambient dissolved oxygen concentrations should also represent critical conditions. Usually, this will be during the maximum stratification period in the late summer or in the spring when upwelling of deep ocean water occurs. The ambient data should be from locations not significantly affected by the discharge or by other waste or thermal discharges, and at the appropriate depths. Dissolved oxygen data collected at these locations should be averaged between the depth of the discharge ports and the plume's trapping level corresponding to the lowest initial dilution which was used to predict the final dissolved oxygen concentration.

The ambient dissolved oxygen concentration can change significantly as a function of depth, depending on the estuary or coastal system, as well as on seasonal influences (e.g., upwelling). As the plume rises during initial dilution, water from deeper parts of the water column is entrained into the plume and advected to the plume's trapping level. If the dissolved oxygen concentration is lower in the bottom of the water column than at the trapping level, the low dissolved oxygen water is advected to a region formerly occupied by water containing higher concentrations of dissolved oxygen. The result is an oxygen depression caused by entrainment.

This oxygen depression caused by the waste discharge and associated entrainment (ΔDO_1) should be computed as the difference between DO_f as defined in Equation VI-7 and the ambient dissolved oxygen concentration at the trapping level (DO_t).

$$\Delta DO_1 = DO_t - DO_f = DO_t - DO_a + (DO_a + IDOD - DO_e)/S_a \qquad \text{VI-9}$$

For cases when the effect of entraining low dissolved oxygen water can be neglected, the oxygen depletion (ΔDO_2) should be computed as the difference between the average ambient oxygen concentration (DO_a) in the entrained water and DO_f as shown below.

$$\Delta DO_2 = DO_a - DO_f = (DO_a + IDOD - DO_e)/S_a \qquad \text{VI-10}$$

ΔDO_2 can be closely approximated by assuming that $DO_a = DO_t$ in both Equations VI-7 and VI-9. Then $\Delta DO_2 = (DO_t + IDOD - DO_e)/S_a$.

These differences can be described as a percentage of the ambient concentration or as a numerical difference, depending on the requirements of the state. In some states, the final dissolved oxygen concentration must be above a specified limit or must be converted to percent saturation to determine if the final concentration is above a prescribed limit. Dissolved oxygen saturation can be determined as a function of temperature and salinity using the method of Green and Carritt (1967) and Hyer et al. (1971) as tabulated in Table VI-8. The applicant may want to consult with the state water quality agency to determine if any other methods are used to determine compliance with the dissolved oxygen standards.

Farfield Dissolved Oxygen Demand

Subsequent to initial dilution, dissolved oxygen in the water column is consumed by the BOD in the wastefield. The effluent BOD_5 after initial dilution is needed to estimate farfield dissolved oxygen depletion. The final BOD_5 concentration can be estimated using the following expression:

$$BOD_f = BOD_a + (BOD_e - BOD_a)/S_a \qquad \text{VI-11}$$

where:

BOD_f = final BOD_5 concentration, mg/l
BOD_a = ambient BOD_5 concentration, mg/l
BOD_e = effluent BOD_5 concentration, mg/l
S_a = initial dilution (flux-averaged).

This equation provides an estimate of the total BOD_5 concentration in the receiving water. The maximum contribution due to the effluent alone can be determined by dividing the effluent BOD_5 concentration by the initial dilution. This estimate is used later in the estimation of farfield effects of the effluent. As a critical case, the maximum monthly average effluent BOD_5 concentration should be used with the initial dilution at the average flow rate. In cases where the BOD_5 concentration increases at high flow rates, the maximum daily BOD_5 concentration and initial dilution at the

TABLE VI-8. DISSOLVED OXYGEN SATURATION VALUES

Temperature (° C)	Dissolved Oxygen Saturation, mg/l								
	Salinity, ppt								
	20	22	24	26	28	30	32	34	36
0	12.8	12.6	12.5	12.3	12.1	12.0	11.8	11.7	11.5
1	12.5	12.3	12.2	12.0	11.8	11.7	11.5	11.4	11.2
2	12.1	12.0	11.9	11.7	11.5	11.4	11.2	11.1	10.9
3	11.8	11.7	11.5	11.4	11.2	11.1	10.9	10.8	10.7
4	11.5	11.4	11.3	11.1	11.0	10.8	10.7	10.5	10.4
5	11.3	11.1	11.0	10.8	10.7	10.6	10.4	10.3	10.1
6	11.0	10.9	10.7	10.6	10.4	10.3	10.2	10.0	9.9
7	10.7	10.6	10.5	10.4	10.2	10.1	9.9	9.8	9.7
8	10.5	10.3	10.2	10.1	9.9	9.8	9.7	9.6	9.4
9	10.2	10.1	10.0	9.8	9.7	9.6	9.5	9.3	9.2
10	10.0	9.9	9.7	9.6	9.5	9.4	9.2	9.1	9.0
11	9.6	9.6	9.5	9.4	9.3	9.2	9.0	8.9	8.8
12	9.5	9.4	9.3	9.2	9.1	9.0	8.8	8.7	8.6
13	9.3	9.2	9.1	9.0	8.9	8.8	8.7	8.5	8.4
14	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3
15	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.1
16	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	8.0
17	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8
18	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.7	7.7
19	8.2	8.1	8.0	8.0	7.9	7.8	7.7	7.6	7.5
20	8.1	8.0	7.9	7.8	7.7	7.6	7.6	7.5	7.4
21	7.9	7.9	7.7	7.7	7.6	7.5	7.5	7.4	7.3
22	7.8	7.7	7.6	7.6	7.5	7.4	7.4	7.3	7.2
23	7.7	7.6	7.5	7.5	7.4	7.3	7.3	7.2	7.1
24	7.6	7.5	7.4	7.4	7.3	7.2	7.2	7.1	7.1
25	7.5	7.4	7.3	7.3	7.2	7.1	7.1	7.0	7.0
26	7.4	7.3	7.2	7.2	7.1	7.1	7.0	7.0	7.0
27	7.2	7.2	7.2	7.1	7.0	7.0	6.9	6.9	6.9
23	7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.9	6.8
29	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.8
30	7.1	7.1	7.0	6.9	6.9	6.8	6.8	6.8	6.7

maximum flow rate should be used to show what the maximum short-term concentrations can be. For existing plants, the previous 12 months of effluent BOD_5 data is used to support the selection of a BOD_5 concentration. For proposed or modified treatment plants where effluent data are not available, monthly average influent BOD_5 data should be provided along with the range of daily values. The average removal efficiency for the new or modified plant is also needed to compute estimated effluent BOD_5 concentrations.

Three approaches to assessing farfield dissolved oxygen demand are described here:

- Simplified Mathematical Models predicting dissolved oxygen depletions using calculation techniques which do not require computer support
- Numerical Models predicting dissolved oxygen depletions using a computer
- Evaluation of Field Data using a data-intensive approach where dissolved oxygen concentrations are measured in the water column and compared to ambient concentrations.

Before undertaking any analysis to determine if farfield BOD exertion causes a violation of the dissolved oxygen standard, the applicant should first check to see if

$$DO_{STD} \leq DO_f - BOD_{fu}, \text{ for critical conditions} \qquad \text{VI-12}$$

where:

DO_{STD} = dissolved oxygen standard
DO_f = dissolved oxygen concentration at the completion of initial dilution
BOD_{fu} = ultimate BOD at the completion of initial dilution ($= BOD_f \times 1.46$).

If the above inequality is true, then the discharge will not violate the dissolved oxygen standard due to BOD exertion and no further analysis of farfield BOD exertion is required. If the inequality is not true, then further analysis is required.

Simplified Mathematical Models--

Oxygen depletion due to coastal or estuarine wastewater discharges is primarily caused by exertion of BOD, although increased nutrient levels can affect oxygen concentrations indirectly by altering algal photosynthesis and respiration rates. BOD consists of a carbonaceous component (CBOD) and nitrogenous component (NBOD). Both components can contribute to oxygen depletion. CBOD is often reported as BOD_5, the five-day BOD. Before using BOD to predict oxygen depletion, the applicant should convert it to BOD_L, the ultimate BOD, by the following relationship:

$$BOD_L = 1.46\ BOD_5 \qquad \text{VI-13}$$

A typical decay rate for CBOD is 0.23/day (base e) at 20° C. A temperature correction should be made as follows:

$$k_T = 0.23 \times 1.047^{T-20} \qquad \text{VI-14}$$

where:

k_T = BOD decay rate at temperature T (° C).

NBOD might not always contribute to oxygen depletion. If the applicant discharges into open coastal waters where there are no other major discharges in the vicinity, the background population of nitrifying bacteria might be negligible. Under these circumstances, the NBOD will not be exerted immediately. In more enclosed estuarine waters, nitrification in the water column has been documented from numerous water quality studies. Applicants should analyze the potential impact of NBOD, if they discharge into estuarine waters.

NBOD can be estimated based on data for total kjeldahl nitrogen (the sum of organic nitrogen and ammonia nitrogen) in the waste discharge using the following relationship:

$$NBOD = 4.57\ (TKN) \qquad \text{VI-15}$$

where:

TKN = total kjeldahl nitrogen.

The decay rate of NBOD can be taken as:

$$k_T = 0.10 \times 1.047^{T-20} \qquad \text{VI-16}$$

where:

k_T = the decay rate at temperature T ($^{\circ}$ C)
0.10 = the decay rate at 20° C (base e).

Simplified mathematical models are an acceptable alternative to the more complex numerical models. The simplest model of oxygen depletion should generally consider that:

- The wastewater plume is submerged at the completion of initial dilution for critical conditions (so that direct reaeration of atmospheric oxygen into the wastefield does not occur).
- Oxygen depletion is a function of distance from the discharge and is caused by carbonaceous oxygen demand (CBOD) and nitrogenous oxygen demand (NBOD).
- The wastefield entrains ambient water as a function of travel time. Lateral dilution is the predominant mechanism of entrainment.

If the applicant demonstrates that the plume will always surface, then the effects of atmospheric reaeration can be included; otherwise they should not be included.

When applying a model which predicts farfield oxygen depletion, it is suggested that the applicant plot the dissolved oxygen depletion as a function of travel time so that the behavior of dissolved oxygen levels in the wastefield can be examined to locate minimum values.

Figure VI-4 shows example oxygen depletion curves as a function of travel time, where the depletion indicated at time, t=0, denotes the depletion immediately following initial dilution. The dissolved oxygen deficits plotted in the figure are relative to the ambient concentration, and tend to approach zero at travel times longer than those shown in the figure.

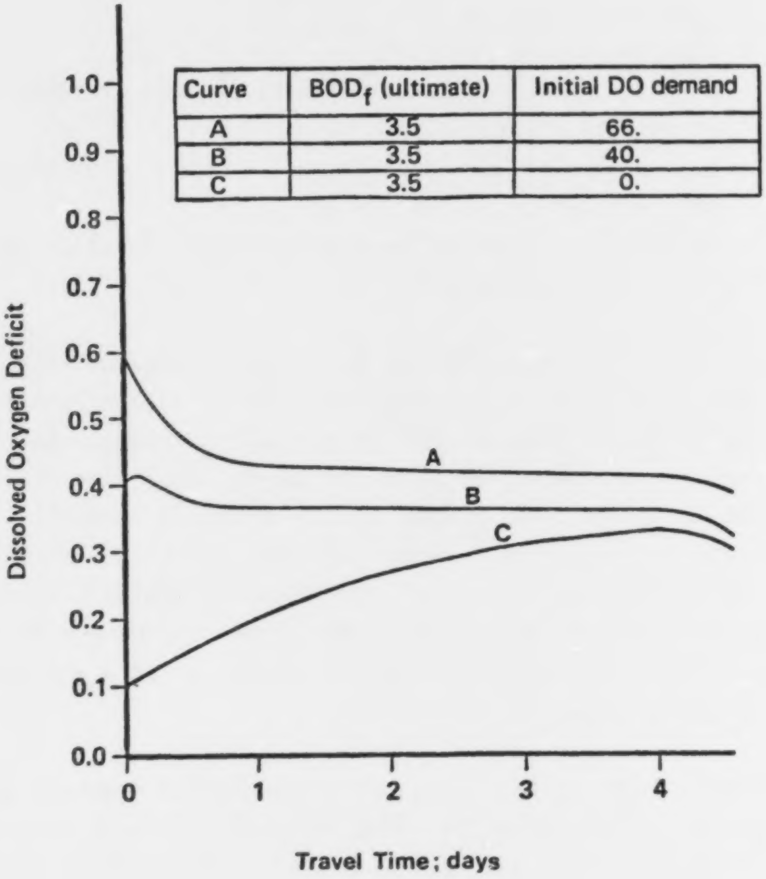
For the three cases, the maximum deficits occur at travel times of:

- 0.0 days for Curve A
- Approximately 0.2 days for Curve B
- Approximately 4.0 days for Curve C.

The primary reason for the difference in magnitude and time of occurrence of the maximum deficits is the IDOD, which varies from a high of 66 mg/l for Curve A to 0.0 mg/l for Curve C. When the IDOD is 66 mg/l (a high value, but one which could be associated with an unusual discharge), the maximum depletion is caused by initial mixing processes, and not by farfield BOD exertion. Conversely, when IDOD is 0.0 mg/l, the maximum depletion is caused by BOD exertion, and occurs at some distance from the discharge.

The simplified farfield oxygen depletion model for coastal waters that is suggested here is based on an approach developed by Brooks (1960) for predicting wastefield dilution subsequent to initial dilution. The dissolved oxygen concentration in the receiving waters can be expressed as a function of travel time as follows:

$$DO(t) = DO_a + \frac{DO_f - DO_a}{D_s} - \left[\frac{L_{fc}}{D_s}\left[1-\exp(-k_c t)\right]\right] - \left[\frac{L_{fn}}{D_s}\left[1-\exp(k_n t)\right]\right] \qquad \text{VI-17}$$



Curve	BOD_f (ultimate)	Initial DO demand
A	3.5	66.
B	3.5	40.
C	3.5	0.

Figure VI-4. Dissolved oxygen deficit versus travel time for a submerged wastefield.

where:

$DO(t)$ = dissolved oxygen concentration in a submerged wastefield as a function of travel time, t, mg/l
DO_a = ambient dissolved oxygen concentration, mg/l
DO_f = dissolved oxygen concentration at the completion of initial dilution, mg/l
k_c = CBOD decay rate constant
k_n = NBOD decay rate constant
L_{fc} = ultimate CBOD concentration above ambient at completion of initial dilution, mg/l
L_{fn} = NBOD concentration above ambient at completion of initial dilution, mg/l
D_s = dilution attained subsequent to initial dilution as a function of travel time.

The above equation expresses the dissolved oxygen deficit which arises due to an initial deficit at the completion of initial dilution (DO_a - DO_f) plus that caused by exertion of BOD in the water column. The last term in the above equation estimates the exertion due to NBOD. The dissolved oxygen deficit tends to decrease at longer travel times as a result of subsequent dilution and to increase as a result of BOD exertion. Depending on the particular case being analyzed, one influence can dominate the other over a range of travel times so that a minimum dissolved oxygen level can occur either immediately following initial dilution or at a subsequent travel time, as previously shown in Figure VI-4.

Prediction of the farfield oxygen distribution requires determination of the dilution attained within the wastefield as a function of time following discharge. For open coastal areas, dilution is often predicted using the 4/3 law (Brooks 1960), which states that the lateral diffusion coefficient increases as the 4/3 power of the wastefield width. In mathematical form:

$$\varepsilon = \varepsilon_o \left(\frac{L}{b}\right)^{4/3}$$

where:

ε = lateral diffusion coefficient, ft^2/sec
ε_o = diffusion coefficient when L = b
L = width of sewage field at any distance from the ZID, ft
b = initial width of sewage field (approximately as the longest dimension of the ZID), ft.

The initial diffusion coefficient can be predicted from:

$$\varepsilon_o = 0.001\ b^{4/3} \qquad \text{VI-19}$$

Based on the 4/3 law, the centerline dilution, D_S, is given by:

$$D_s = \left[\operatorname{erf} \left(\frac{1.5}{\left(1 + \frac{8\ \varepsilon_o\ t}{b^2}\right)^3 - 1} \right)^{1/2} \right]^{-1} \qquad \text{VI-20}$$

where:

t = travel time, h
erf = the error function.

The 4/3 law is not always applicable, especially in confined coastal areas or estuaries. Under these circumstances, it is more conservative to assume the diffusion coefficient is a constant. The subsequent dilution is then expressible as:

$$D_s = \left[\operatorname{erf} \left(\frac{b^2}{16\ \varepsilon_o\ t} \right)^{1/2} \right]^{-1} \qquad \text{VI-21}$$

These two equations are cumbersome to use, especially if repeated applications are needed. To facilitate predicting subsequent dilutions, values of D_S are tabulated in Table VI-9 for different initial widths (b) and travel times (t). The initial sewage field widths range from 10 to 5,000 ft and travel times range from 0.5 to 96 hours.

TABLE VI-9. SUBSEQUENT DILUTIONS[a] FOR VARIOUS INITIAL FIELD WIDTHS AND TRAVEL TIMES

Travel Time(hr)	Initial Field Width (ft)					
	10	50	100	500	1000	5000
0.5	2.3/ 5.5	1.5/ 2.0	1.3/ 1.6	1.0/ 1.1	1.0/ 1.0	1.0/ 1.0
1.0	3.1/ 13.	2.0/ 3.9	1.6/ 2.6	1.2/ 1.3	1.1/ 1.1	1.0/ 1.0
2.0	4.3/ 32.	2.7/ 8.5	2.2/ 5.1	1.4/ 1.9	1.2/ 1.5	1.0/ 1.0
4.0	6.1/ 85.	3.7/ 21.	3.0/ 11.	1.9/ 3.5	1.5/ 2.3	1.1/ 1.2
8.0	8.5/>100.	5.2/ 53.	4.1/ 29.	2.5/ 7.3	2.0/ 4.4	1.4/ 1.7
12.	10. />100.	6.3/ 95.	5.1/ 50.	3.0/ 12.	2.4/ 6.8	1.6/ 2.3
24.	15. />100.	8.9/>100.	7.1/ 100.	4.2/ 30.	3.4/ 16.	2.1/ 4.4
48.	21. />100.	13. />100.	10. />100.	5.9/ 80.	4.7/ 41.	2.8/10.
72.	26. />100.	15. />100.	12. />100.	7.3/>100.	5.8/ 73	3.4/17.
96.	29. />100.	18. />100.	14. />100.	8.4/>100.	6.6/100.	3.9/24.

---

[a] The dilutions are entered in the table as N_1/N_2, where N_1 is the dilution assuming a constant diffusion coefficient, and N_2 is the dilution assuming the 4/3 law.

The table also reveals that the predicted dilutions are significantly different, depending on the relationship obeyed by the lateral diffusion coefficient. In many instances, the 4/3 law might overestimate subsequent dilution, even if the outfall is in coastal waters. To attain the subsequent dilutions predicted by the 4/3 law at large travel times, a significant amount of dilution water must be available. Since many outfalls, particularly small ones, are often not too far from shore, the entrainment rate of dilution water can be restricted by the presence of the shoreline and the depth of the water. As the wastefield widens significantly, the rate of entrainment could decrease, and the 4/3 law no longer be obeyed. It is suggested that applicants be conservative and base subsequent dilution on a constant lateral diffusion coefficient, rather than the 4/3 law. However, if the applicant can show that the 4/3 law (or some other relationship) is applicable to the discharge site, then that relationship should be used.

If the applicant's discharge is near the mouth of a wide estuary, the approach just discussed can be directly used to predict oxygen depletion. If, however, the applicant discharges into a long narrow estuary, then it is likely that the sides of the estuary will limit the lateral dilution which is attainable. Under these conditions, the maximum dissolved oxygen deficit (with respect to saturation) can be predicted as:

$$D = \frac{kW}{A(k_2-k)}\left[\frac{1}{\sqrt{4kE_L}} - \frac{1}{\sqrt{4k_2E_L}}\right] \qquad \text{VI-22}$$

where:

D = dissolved oxygen deficit
A = cross-sectional area of the estuary near the discharge site
k = CBOD decay rate constant
k_2 = reaeration rate constant
E_L = longitudinal dispersion coefficient
W = mass loading rate of CBOD.

The applicant can predict the deficits due to NBOD by using the appropriate k and W values and adding the two deficits to get the total.

Using reasonable values for the constants, the total dissolved oxygen deficit for discharge to narrow estuaries becomes:

$$D = (3.14\ W_c + 2.55\ W_n)\ 10^{-4}/A \qquad \text{VI-23}$$

where:

A = cross-sectional area in m^2
W_C = mass emission rate of CBOD, g/day
W_n = mass emission rate of NBOD, g/day
D = dissolved oxygen deficit, mg/l.

The NBOD term can be added when data are available.

Numerical Models--

Numerical models are an acceptable method of predicting oxygen depletion caused by a discharge. Numerical models may consider the combined effect of farfield demand in the water column, as discussed above, and the oxygen demand associated with organic sediments. If not, the applicant may have to augment the numerical modeling analysis to address unanswered questions associated with sediment oxygen demand.

The applicant should try to isolate the impact of the outfall on dissolved oxygen concentrations by considering that the applicant's discharge is the sole source of oxygen depletion in the system being modeled. The applicant can then predict the dissolved oxygen depletion caused by the discharge (by subtracting the background dissolved oxygen level from the levels predicted by the model). This approach also simplifies the applicant's analysis because data from other wastewater sources are not required.

There are several specific guidelines which can be offered to applicants who choose to use numerical models. Typically, the most severe dissolved oxygen depletion due to BOD exertion occurs when the water column is density stratified and the wastefield remains submerged following initial dilution. If such conditions occur at the applicant's outfall site, then the numerical model should be layered vertically, with a minimum of two layers. The plume should be discharged into the bottom layer to simulate the submerged discharge with the consequence that direct atmospheric reaeration is not present in this layer.

The applicant should set up the grid system for the numerical model such that the smallest segments are located in the vicinity of the diffuser and gradually increase in size with distance from the diffuser. The volume of the segments in the immediate vicinity of the diffuser should approximate the volume of the ZID in order to prevent an initial dilution which is artificially higher than it should be and which would cause the model to underestimate dissolved oxygen depletion. The applicant might choose to experiment with grid configuration by starting with a coarse grid and then decreasing grid size until the model results do not significantly change.

A steady-state numerical model will be acceptable for the dissolved oxygen analysis because dynamic or unsteady analyses are generally more costly, more difficult to implement, and require more data. The applicant should consider, however, whether intratidal variations can cause more severe depletions than are predicted by a steady-state model which calculates average oxygen depletions over a tidal cycle. Slack tide, for example, might be critical because oxygen-demanding materials can accumulate in the vicinity of the discharge. The applicant might want to augment the steady-state modeling analysis by an abbreviated sampling program to determine dissolved oxygen depletions during slack-tide periods within a tidal cycle. Intratidal variations are likely to be more important in enclosed estuaries than along open coastal areas.

Evaluation of Field Data--

Extensive field data collection and analysis are required to fully implement this approach. Limited samples of water column dissolved oxygen may be inadequate to demonstrate compliance with standards under critical conditions. Limited information should be supplemented with analyses based on numerical or simplified mathematical modeling.

These statements should not discourage applicants from collecting and submitting dissolved oxygen data from the vicinity of a current discharge.

To the contrary, such data, if available, should be submitted, particularly if the section 301(h) application is for a current discharge or for an improved/altered discharge at the same location. However, the data might reveal only a portion of the impact of the wastefield, for the following reasons:

- The location of the maximum oxygen depletion might not be sampled.
- The sampling program could have been conducted during a period which was not critical with respect to the discharge and/or receiving water conditions. Critical discharge conditions are generally associated with high effluent BOD and high volumetric flow rates. Critical receiving water conditions are usually associated with minimum initial dilutions (maximum density stratification), maximum water temperatures, and possibly slack-tide conditions.
- Ambient dissolved oxygen concentrations can vary spatially and temporally for conditions unrelated to the discharge (e.g., upwelling effects). Consequently, dissolved oxygen depletions associated with the discharge can be masked by background variability.

Some applicants might have access to dissolved oxygen demand data collected adjacent to another outfall at a nearby coastal area and attempt to use that data to show that their own discharge will not violate dissolved oxygen standards. This approach can be, but is not always, reliable. The applicants should include in the application sufficient information such that the data collection program for the nearby area can be reviewed, and then show that the predicted dissolved oxygen depletions are the maximum likely to be produced at the nearby discharge site. The applicant should also demonstrate that the results of the nearby discharge are extrapolatable to the applicant's discharge. Essentially, this means that the dissolved oxygen depletion at the adjacent discharge (both due to BOD utilization and sediment oxygen demand) will be as severe, or more severe, than at the applicant's discharge.

Sediment Oxygen Demand

The oxygen depletion due to a steady sediment oxygen demand can be predicted by:

$$\Delta DO = \frac{\overline{S}_B X_M}{86{,}400\ UHD} = \frac{a\ \overline{S}\ k_d\ X_M}{86{,}400\ UHD} \qquad \text{VI-24}$$

where:

ΔDO = oxygen depletion, mg/l

$\overline{S}_B$ = average benthic oxygen demand over the deposition area, g O_2/m^2/day

X_M = length of deposition area (generally measured in longshore direction), m

H = average depth of water column influenced by sediment oxygen demand, measured above bottom, m

U = minimum sustained current speed over deposition area, m/sec

k_d = sediment decay rate constant (0.01/day)

a = oxygen:sediment stoichiometric ratio (1.07 mg O_2/mg sediment)

$\overline{S}$ = average concentration of deposited organic sediments over the deposition area, g/m^2

D = dilution caused by horizontal entrainment of ambient water as it passes over the deposition area (always greater than or equal to 1).

Both $\overline{S}$ and X_M can be determined from the analysis performed in the section on "Suspended Solids Deposition." Figure VI-1 in that section shows an example plot of seabed deposition. For that example an appropriate estimate of $\overline{S}$ is the average of the maximum and minimum values, or

$$\frac{100 + 5}{2} = 52\ g/m^2 \qquad \text{VI-25}$$

The distance X_m, measured parallel to the coast and within the 5 g/m^2 contour, is 8,000 m.

The depth of water affected by the sediment oxygen demand is not really a constant value as suggested by the previous formula but varies as a function of the travel time across the zone of deposition. The affected depth H (in meters) is chosen to represent the average depth influenced by the sediment oxygen demand and can be estimated as:

$$H = 0.8 \left(\frac{\varepsilon_z X_M}{U} \right)^{1/2} \qquad \text{VI-26}$$

where:

ε_z = vertical diffusion coefficient (cm^2/sec).

For the example case where U = 3 cm/sec, X_M = 8,000 m, and $\varepsilon_z = 1$ cm^2/sec,

$$H = 0.8 \times \left(\frac{1 \times 8,000 \times 100}{3} \right)^{1/2} \times \frac{1}{100} \text{ m} = 4.1 \text{ m} \qquad \text{VI-27}$$

If the applicant desires to compute a value of vertical diffusivity, the following empirical expression can be used:

$$\varepsilon_z = \frac{10^{-4}}{\frac{1}{\rho} \frac{d\rho}{dz}} \qquad \text{VI-28}$$

where:

ε_z = vertical diffusion coefficient, cm^2/sec
ρ = ambient water density, kg/m^3 (1,024)
$\frac{d\rho}{dz}$ = ambient density gradient, kg/m^4.

The density gradient used should reflect the most severe stratification condition likely to occur during the critical period.

The dilution D can be found from Table VI-9 where the field width is the width of the deposition area. For the appropriate travel time and field width the smaller of the two estimates shown in the table should be used.

In the section on "Suspended Solids Deposition," the applicant is asked to compute the long-term accumulation and the critical 90-day accumulation. Since the critical 90-day accumulation might exceed the long-term average, the applicant should use the more critical case when predicting sediment oxygen demand.

Oxygen Demand due to Resuspension of Sediments

It is more difficult to accurately predict oxygen demand due to resuspension than due to either farfield BOD decay or a steady benthic oxygen demand. To simplify the analysis, the approach here considers a worst-case situation. The amount of sediment to be resuspended is equal to the critical 90-day accumulation, which is found using the methods discussed in the above guidance on "Suspended Solids Deposition."

In order for the material to remain suspended the ambient current speed has to be sufficiently great, so that the volume of water containing the resuspended material increases over time as ambient water is entrained. It is assumed that this process continues for up to 24 hours.

The applicant should compute the oxygen depletion as a function of time during this period. This can be done using the following relationship:

$$\Delta DO = \frac{\overline{S}_r}{DH}\left[1-\exp\left(\frac{-k_r t}{24}\right)\right] \qquad \text{VI-29}$$

where:

ΔDO = oxygen depletion, mg/l
$\overline{S}_r$ = average concentration (in g/m^2) of resuspended organic sediment (based on 90-day accumulation)
H = depth of water volume containing resuspended materials, m

k_r = decay rate of resuspended sediments (0.1/day)
t = elapsed time following resuspension, h (t varies from 0 to 24 h)
D = dilution as defined previously (generally set equal to 1).

The variable H is a function of travel time and can be predicted from:

$$H = \frac{1.6}{100} (3{,}600 \; t \; \varepsilon_z')^{1/2} \qquad \text{VI-30}$$

where:

ε_z' = vertical diffusion coefficient when resuspension is occurring (5 cm^2/sec)
t = elapsed time following resuspension, h.

The applicant should check to be sure that H does not exceed the water depth. If it does, set H equal to the water depth.

The concentration of resuspended sediments $\overline{S}_r$ can be approximated as the average concentration over the width of the zone of deposition. This can be determined directly from the contour plots of sediment accumulation, developed in response to the guidance on "Suspended Solids Deposition."

The applicant should calculate ΔDO for 3-hour increments for a period of up to 24 hours. The results can be tabulated as shown below. Submit data and calculations in the application.

t (hr)	DO (mg/l)
0	0
3	↓
6	
9	
12	
15	
18	
21	
24	predictions

Most often a maximum depletion will occur somewhere in the 24-hour period, with depletions decreasing for larger travel times.

LIGHT TRANSMITTANCE

Increased suspended solids concentrations associated with municipal discharges can cause a decrease in light penetration within the water column. Reductions in light penetration can result in a decrease in phytoplankton productivity as well as a reduction in the areal distribution of attached macroalgae such as kelp. Therefore, several states have enacted regulations governing the allowable levels of interference with light transmittance.

The evaluation of light transmittance may require the measurement of one or more water clarity parameters and a comparison of recorded values in the vicinity of the outfall with those recorded in control areas. Parameters which are widely measured to assess light transmittance include: turbidity, Secchi disc depth, beam transmittance, and downward irradiance. While many of the state requirements are very specific in terms of the light transmittance measurements, others leave the selection of the sampling methods to the discretion of the applicant.

Turbidity is a measure of the optical clarity of water, and many standards are written in terms of Nephelometric Turbidity Units (NTU). Measurements are made with a nephelometer which provides a comparison of the light-scattering characteristics of the sample with a standard reference. Differences in the optical design of nephelometers can cause differences in measured values even when calibrated against the same turbidity standard. For this reason, caution must be exercised when comparing measurements of turbidity made from different field sampling programs.

A Secchi disc is used to make visual observations of water clarity. Records of the depth at which the Secchi disc is just barely visible can be used to make comparisons of light transmittance among sampling sites. Measurements of Secchi disc depth are probably the most widely used means of estimating light penetration. The Secchi disc is easy to use, accurate over a wide range of conditions, can be used to estimate the attenuation coefficients for collimated and diffuse light, and therefore, to estimate the depth of the euphotic zone. However, since a wastewater plume may be held below the upper regions of this zone during periods of stratification, Secchi disc measurements may not be appropriate under all conditions.

Beam transmittance is measured with a transmissometer and is a measure of the attenuation of a collimated beam of artificial light along a fixed path length (usually 1 meter). The attenuation is caused by both suspended and dissolved material as well as the water itself. These measurements, therefore, provide information about both the absorption and scattering properties of the water. The attenuation of a collimated beam of light in a water path is described by the Beer-Lambert law:

$$T_d = e^{-\alpha d} \qquad \text{VI-31}$$

where:

T_d = the proportion of light transmitted along a path of length d, (m)
α = light attenuation coefficient, (m^{-1}).

Measurements of beam transmittance are made in situ at any depth.

The intensity and attenuation of daylight penetration are measured with an irradiance meter which utilizes a photovoltaic cell to record incident light levels. Measurements are made just below the surface and at selected depth intervals throughout the water column so that light attenuation over specific depths can be determined. Unlike beam transmittance measurements, irradiance measurements are influenced by sunlight as well as surface conditions.

Empirical relationships can be derived among the light transmittance parameters measured by these methods which permit the estimation of one parameter based on recorded values of another. The estimation of these parameters from predicted suspended solids concentrations can also be made. The derivation of these relationships from existing data, in some instances, may be sufficient to allow for the demonstration of compliance with state standards. Existing data can also be used to predict the transparency characteristics in the vicinity of an improved discharge. Alternatively, a sampling program can be designed which will permit an assessment of compliance with light transmittance standards based on such empirical relationships.

Where standards are written in terms of maximum allowable turbidity or turbidity increase, the ability to predict the turbidity in the receiving water at the completion of initial dilution can be utilized to demonstrate compliance. Treating turbidity as a conservative parameter, the turbidity in the receiving water at the completion of initial dilution can be predicted as:

$$T_f = T_a + \frac{T_e - T_a}{S_a} \qquad \text{VI-32}$$

where:

T_f = turbidity in receiving water at the completion of initial dilution (typical units: NTU or JTU)
T_a = ambient or background turbidity
T_e = effluent turbidity
S_a = initial dilution.

Initial dilution can be predicted based on the methods presented earlier in the section on Physical Assessment. Equation VI-32 can be used, then, to directly evaluate compliance with standards written in terms of maximum allowable turbidity or a turbidity increase.

Laboratory experimental work can also be used in lieu of field sampling to demonstrate compliance with those standards written in terms of an allowable turbidity increase. These analyses consist of determining the turbidity of a seawater effluent-mixture prepared in the same proportions corresponding to the predicted concentrations following initial dilution. Experiments should be conducted in such a manner so as to simulate worst-case conditions. Simulations of expected receiving water turbidity should be made for periods of highest effluent turbidity (greatest suspended solids concentrations) as well as lowest initial dilutions. Values of the initial turbidity of the seawater, the effluent mixture, and the simulated dilution should accompany all test results.

By deriving a relationship between turbidity and Secchi depth and utilizing the method of prediction for turbidity in the receiving water following initial dilution (Equation VI-32), an evaluation of compliance with state standards written in terms of Secchi depth can be made. Secchi disc and turbidity can be related in the following manner. Assume that the extinction coefficient of visible light (α) is directly proportional to turbidity (T) and inversely proportional to Secchi disc (SD), or:

$$\alpha = k_1 T \qquad \text{VI-33}$$

and

$$\alpha = \frac{k_2}{SD} \qquad \text{VI-34}$$

where k_1 and k_2 are constants which need not be specified since they cancel out in further calculations. These two relationships have theoretical bases, as discussed in Austin (1974) and Graham (1966). Combining those two expressions, the relationship between Secchi disc and turbidity becomes:

$$T = \frac{k_2}{k_1} \frac{1}{SD} \qquad \text{VI-35}$$

When state standards are written in terms of Secchi disc, it is convenient to combine Equations VI-32 and VI-35 to yield:

$$\frac{1}{SD_f} = \frac{1}{SD_a} + \frac{\frac{1}{SD_e} - \frac{1}{SD_a}}{S_a} \qquad \text{VI-36}$$

or

$$SD_e = \left[\left(\frac{1}{SD_f} - \frac{1}{SD_a} \right) S_a + \frac{1}{SD_a} \right]^{-1} \qquad \text{VI-37}$$

where:

SD_f = minimum allowable Secchi disc reading in receiving water such that the water quality standard is not violated

SD_a = ambient Secchi disc reading

S_a = minimum initial dilution which occurs when the plume surfaces

SD_e = critical Secchi disc depth of effluent.

In this manner, the critical effluent Secchi depth (SD_e) can be calculated. An effluent reading higher than this value indicates that standards will not be violated. This method of predicting the final Secchi depth in the receiving water can be utilized to provide an estimate of the effect of the wastewater discharge on the receiving water. This method should only be used where the standard is exclusively in terms of the acceptable decrease in the Secchi depth.

Values of the critical effluent Secchi depth (SD_e) calculated using Equation VI-37 are presented in Table VI-10. In this example, the water quality standard for the minimum Secchi visibility is 1 m (3.3 ft). Effluent having a Secchi depth greater than those presented for the selected ambient conditions and initial dilution will not violate the example receiving water's clarity standard. Primary effluents typically have Secchi disc values of 5 to 30 cm (2 to 12 in). For this case, with an initial dilution greater than 40 and an ambient Secchi depth of 2 m (6.6 ft) or greater, these calculations indicate that the standard would not be violated.

Since Secchi disc measurements are made from the water's surface downward, critical conditions (in terms of the Secchi disc standard) will occur when the initial dilution is just sufficient to allow the plume to surface. It is notable that maximum turbidity or light transmittance impacts of a wastewater plume will occur when the water column is

TABLE VI-10. CALCULATED VALUES FOR THE CRITICAL EFFLUENT SECCHI DEPTH (cm) FOR SELECTED AMBIENT SECCHI DEPTHS, INITIAL DILUTIONS, AND A WATER QUALITY STANDARD FOR MINIMUM SECCHI DISC VISIBILITY OF 1 m

Initial Dilution	Ambient Secchi Depth (m)				
	2	3	4	5	10
10	18	14	13	12	11
20	10	7	7	6	6
40	5	4	3	3	3
60	3	2	2	2	2
100	2	1	1	1	1

stratified, the plume remains submerged, and initial dilution is a minimum. Under these same conditions, however, Secchi disc readings might not be altered at all, if the plume is trapped below the water's surface at a depth exceeding the ambient Secchi disc depth.

The ability to relate measurements of turbidity to the attenuation coefficient (α) for collimated light has been demonstrated by Austin (1974). The attenuation coefficient can be expressed in terms of turbidity as:

$$\alpha = k \times JTU \qquad \text{VI-38}$$

where:

JTU = turbidity, in Jackson Turbidity Units
k = coefficient of proportionality.

Combining Equations VI-31 and VI-38, turbidity can be expressed as:

$$JTU = \frac{-\ln T_d}{kd} \qquad \text{VI-39}$$

where:

T_d = fraction of beam transmittance over distance d.

The coefficient of proportionality (k) takes on values between 0.5 and 1.0. Therefore, in order to utilize these relationships to demonstrate compliance with a turbidity standard based on existing light transmittance data, the value of k must be determined empirically. This requires simultaneous measurements of beam transmittance and determination of turbidity covering the complete range of existing light transmittance records. If data are not available, the "k" value can be set equal to 1 as a conservative estimate.

Where a relationship between suspended solids concentration and beam transmittance data at a particular site can be derived, the suspended solids concentration at the completion of initial dilution from Equation VI-1 can be used to predict compliance with standards written in terms of light transmittance.

Field sampling may be required in situations where water clarity has not been previously measured in the vicinity of the outfall or where the previously described methods for demonstrating compliance are not applicable. Minimum sampling should include replicate measurements of the appropriate water clarity parameters during critical periods defined on the basis of spatial and temporal variation in effluent quality and oceanographic conditions. Light transmittance measurements should be made at the boundary of the ZID and at least one control site. Where the method of determining compliance with light transmittance regulations is not specified by the applicable standard, use of a beam transmissometer is recommended.

The optical properties of coastal waters are influenced by such factors as a distance from a shore, water depth at the sampling site, and the proximity to river discharges. Consideration must be given to these factors when selecting a control sampling location, so that the effects of the outfall can be isolated. Additionally, where turbidity or beam transmittance is the parameter measured, sampling should be conducted throughout the water column at 1- to 3-m (3.3- to 6.6-ft) intervals.

As a general guideline, water clarity measurements should be made both during periods of maximum flow and maximum effluent concentrations of suspended solids. However, the prescribed methods can also influence the selection of critical sampling periods. Where Secchi disc readings are specified by state regulations, for example, sampling should be conducted when the plume is known to surface.

Replicate sampling should be conducted at all sampling stations to permit statistical comparison of all measurements. Replicate surface observations or profile samples should be collected at each sampling location. Information on currents in the vicinity of the outfall should be reviewed so that sampling at the outfall is conducted in that area expected to be influenced by the wastewater plume.

ANALYSIS OF pH

In most settings the influence of a municipal waste discharge on the receiving water pH is small. This section provides a method to determine whether the pH change due to a waste discharge is significant and to determine if standards are violated.

The pH at completion of initial dilution can be estimated from Table VI-11. The results shown in Table VI-11 were generated by a pH-alkalinity model based on the carbonate system which simulates the mixing of effluent and seawater. Because the waste plumes are usually submerged during initial dilution, no exchange with the atmosphere is included. The results are based on a seawater alkalinity of 2.3 meq/l (Stumm and Morgan 1980), and dissociation constants from Stumm and Morgan (1980) and Dickson and Riley (1979).

Effluent alkalinity depends on the alkalinity of the source water and any infiltrating water, the type of treatment process, and the volume and type of industrial waste entering the treatment plant. Effluent alkalinity can range from 0 to 6.0 meq/l. A typical value for effluent alkalinity is 2 meq/l or higher (Metcalf and Eddy, Inc. 1979). Because alkalinity data are scarce, final pH values are calculated for a range of alkalinities in Table VI-11. If significant industrial waste is present or pure oxygen or nitrification-denitrification treatment processes are used, the effluent pH and alkalinity should be measured. For cases of weak primary effluents with no industrial waste components, an alkalinity value of 0.1 meq/l with an effluent pH of 6.0 can be used to estimate the final pH. If the lowest effluent pH is 6.5 or higher, an alkalinity value of 0.5 meq/l with an effluent pH of 6.5 can be used to estimate the final pH.

The applicant should first estimate the pH at completion of initial dilution for the case when the effluent pH is 6.0 and the ambient pH is equal to the minimum ambient pH in the vicinity of the discharge. The estimated value should be compared to the appropriate state standard to determine if the standard is met. If no receiving water pH data are available, the lower value of the state's allowable pH range can be used. No further analysis is needed if the state standard is met. If not, the applicant should discuss the likely frequency of the violations.

TABLE VI-11. ESTIMATED pH VALUES AFTER INITIAL DILUTION

Seawater Temp. °C	5°C					15°C					25°C				
Seawater pH	Initial Dilution					Initial Dilution					Initial Dilution				
	10	25	50	75	100	10	25	50	75	100	10	25	50	75	100
Effluent pH = 6.0 Alk = 0.1															
7.0	6.94	6.97	6.98	6.98	6.99	6.95	6.97	6.98	6.99	6.99	6.95	6.98	6.99	6.99	6.99
7.5	7.37	7.44	7.47	7.47	7.48	7.40	7.45	7.47	7.48	7.48	7.42	7.46	7.48	7.48	7.49
7.7	7.56	7.64	7.67	7.67	7.68	7.59	7.65	7.67	7.68	7.68	7.62	7.66	7.68	7.68	7.69
8.0	7.88	7.95	7.97	7.97	7.98	7.91	7.96	7.98	7.98	7.99	7.94	7.97	7.98	7.99	7.99
8.3	8.21	8.26	8.28	8.28	8.29	8.24	8.27	8.28	8.29	8.29	8.25	8.25	8.29	8.29	8.29
8.5	8.43	8.47	8.48	8.48	8.49	8.45	8.48	8.49	8.49	8.49	8.46	8.48	8.49	8.49	8.49
Effluent pH = 6.0 Alk = 0.6															
7.0	6.74	6.87	6.93	6.95	6.96	6.77	6.89	6.94	6.96	6.97	6.77	6.89	6.94	6.96	6.97
7.5	6.98	7.23	7.35	7.40	7.42	7.03	7.27	7.38	7.42	7.44	7.08	7.31	7.40	7.43	7.45
7.7	7.07	7.39	7.53	7.59	7.61	7.16	7.45	7.57	7.61	7.63	7.24	7.51	7.60	7.64	7.65
8.0	7.27	7.70	7.85	7.90	7.93	7.44	7.79	7.90	7.93	7.95	7.60	7.85	7.93	7.95	7.96
8.3	7.66	8.08	8.20	8.23	8.25	7.89	8.15	8.23	8.25	8.26	8.02	8.19	8.24	8.26	8.27
8.5	8.01	8.33	8.42	8.44	8.46	8.18	8.38	8.44	8.46	8.47	8.27	8.41	8.45	8.47	8.47
Effluent pH = 6.0 Alk = 1.0															
7.0	6.63	6.81	6.89	6.92	6.94	6.66	6.83	6.90	6.93	6.95	6.67	6.84	6.91	6.93	6.95
7.5	6.80	7.10	7.27	7.34	7.37	6.86	7.15	7.31	7.36	7.39	6.90	7.20	7.33	7.38	7.41
7.7	6.86	7.23	7.43	7.52	7.56	6.94	7.30	7.49	7.56	7.59	7.01	7.38	7.53	7.58	7.61
8.0	6.98	7.48	7.75	7.83	7.87	7.12	7.63	7.82	7.88	7.91	7.29	7.73	7.86	7.90	7.92
8.3	7.21	7.91	8.12	8.18	8.21	7.51	8.04	8.17	8.21	8.23	7.76	8.10	8.19	8.22	8.23
8.5	7.51	8.20	8.35	8.40	8.42	7.89	8.28	8.39	8.42	8.44	8.06	8.32	8.40	8.42	8.43
Effluent pH = 6.0 Alk = 2.0															
7.0	6.45	6.68	6.81	6.86	6.89	6.48	6.71	6.83	6.88	6.90	6.50	6.72	6.84	6.88	6.91
7.5	6.55	6.88	7.11	7.21	7.27	6.60	6.94	7.16	7.25	7.31	6.64	6.99	7.20	7.29	7.34
7.7	6.58	6.96	7.23	7.36	7.43	7.64	7.04	7.31	7.43	7.50	6.70	7.12	7.39	7.49	7.54
8.0	6.64	7.11	7.49	7.66	7.75	6.73	7.28	7.65	7.77	7.83	6.33	7.45	7.75	7.84	7.88
8.3	6.73	7.41	7.91	8.06	8.12	6.89	7.73	8.06	8.14	8.18	7.11	7.91	8.12	8.18	8.21
8.5	6.83	7.78	8.20	8.31	8.36	7.10	8.07	8.30	8.37	8.40	7.48	8.18	8.35	8.40	8.42
Effluent pH = 6.5 Alk = 0.5															
7.0	6.92	6.96	6.98	6.98	6.99	6.93	6.97	6.98	6.98	6.99	6.93	6.97	6.98	6.98	6.99
7.5	7.32	7.42	7.45	7.47	7.47	7.34	7.43	7.46	7.47	7.48	7.37	7.44	7.46	7.47	7.48
7.7	7.49	7.61	7.65	7.66	7.67	7.53	7.63	7.66	7.67	7.67	7.56	7.64	7.66	7.67	7.67
8.0	7.80	7.92	7.96	7.97	7.97	7.85	7.94	7.96	7.97	7.98	7.88	7.94	7.96	7.97	7.97
8.3	8.15	8.24	8.26	8.27	8.28	8.19	8.25	8.27	8.27	8.28	8.20	8.25	8.26	8.27	8.27
8.5	8.38	8.45	8.47	8.48	8.48	8.40	8.45	8.47	8.47	8.48	8.40	8.44	8.46	8.46	8.46
Effluent pH = 6.5 Alk = 1.0															
7.0	6.85	6.93	6.96	6.97	6.98	6.87	6.94	6.97	6.98	6.98	6.88	6.94	6.97	6.98	6.98
7.5	7.18	7.35	7.42	7.44	7.46	7.22	7.37	7.43	7.45	7.46	7.26	7.40	7.45	7.46	7.47
7.7	7.31	7.53	7.61	7.64	7.65	7.39	7.57	7.63	7.65	7.66	7.45	7.60	7.65	7.66	7.67
8.0	7.60	7.84	7.92	7.95	7.96	7.72	7.89	7.94	7.96	7.97	7.80	7.92	7.96	7.97	7.98
8.3	8.00	8.19	8.24	8.26	8.27	8.09	8.22	8.26	8.27	8.28	8.14	8.24	8.27	8.28	8.28
8.5	8.26	8.41	8.45	8.47	8.47	8.33	8.43	8.46	8.47	8.48	8.36	8.44	8.47	8.48	8.48
Effluent pH = 6.5 Alk = 2.0															
7.0	6.75	6.88	6.93	6.95	6.96	6.78	6.89	6.94	6.96	6.97	6.79	6.90	6.94	6.96	6.97
7.5	6.99	7.23	7.35	7.39	7.42	7.04	7.27	7.37	7.41	7.43	7.08	7.30	7.39	7.42	7.44
7.7	7.07	7.38	7.53	7.58	7.61	7.15	7.44	7.56	7.61	7.63	7.23	7.49	7.59	7.62	7.64
8.0	7.25	7.67	7.84	7.89	7.92	7.41	7.77	7.88	7.92	7.94	7.55	7.82	7.90	7.93	7.94
8.3	7.61	8.06	8.18	8.22	8.24	7.84	8.13	8.21	8.23	8.25	7.96	8.16	8.22	8.24	8.25
8.5	7.95	8.30	8.40	8.43	8.45	8.12	8.35	8.42	8.44	8.45	8.20	8.36	8.42	8.43	8.44
Effluent pH = 9.0 Alk = 2.0															
7.0	7.03	7.01	7.00	7.00	7.00	7.04	7.01	7.00	7.00	7.00	7.04	7.01	7.00	7.00	7.00
7.5	7.52	7.51	7.50	7.50	7.50	7.51	7.50	7.50	7.50	7.50	7.51	7.50	7.50	7.50	7.50
7.7	7.71	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
8.0	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.3	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30
8.5	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
Effluent pH = 9.0 Alk = 4.0															
7.0	7.07	7.03	7.01	7.01	7.00	7.08	7.03	7.01	7.01	7.00	7.08	7.03	7.01	7.01	7.00
7.5	7.54	7.51	7.50	7.50	7.50	7.54	7.51	7.50	7.50	7.50	7.53	7.51	7.50	7.50	7.50
7.7	7.71	7.70	7.70	7.70	7.70	7.71	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
8.0	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.3	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30
8.5	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
Effluent pH = 9.0 Alk = 6.0															
7.0	7.10	7.04	7.02	7.01	7.01	7.11	7.04	7.02	7.01	7.01	7.11	7.05	7.02	7.01	7.01
7.5	7.56	7.52	7.51	7.50	7.50	7.56	7.52	7.51	7.50	7.50	7.54	7.51	7.50	7.50	7.50
7.7	7.72	7.71	7.70	7.70	7.70	7.71	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70	7.70
8.0	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
8.3	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30	8.30
8.5	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50

Note: Values are shown to 2 decimal places to allow interpolation but should be rounded to 1 decimal place for comparison to standards.

If the effluent pH drops below 6.0, the applicant should indicate approximately how many times per year effluent pH values below 6.0 occurred and what the suspected cause was. If effluent pH values below 6.0 occur frequently, a laboratory test of pH after mixing the effluent and seawater should be done for the critical conditions. The sample mixture should not be allowed to equilibrate with the atmosphere. The pH should be measured at close intervals until no further change in pH is observed. The applicant should describe conditions of the test including temperature, pH, and alkalinity of the effluent and seawater, initial dilution, and the measured values after mixing. The measured values should then be compared to the applicable standard to determine if a violation is likely. The frequency of any violations should be estimated.

OTHER PARAMETERS COVERED BY APPLICABLE WATER QUALITY STANDARDS

This section provides guidance for evaluating the effects of the discharge on other parameters for which water quality standards may exist. Parameters which may be included are total dissolved gases, coliform bacteria, chlorine residual, temperature, salinity, radioactivity, and nutrients. Parameters concerned with aesthetic effects which also may be included are color, floating material, taste and odor, and hydrocarbons (i.e., grease and oil). For most dischargers, temperature, salinity, and radioactivity standards are unlikely to be violated. Aesthetic effects are more likely to occur when the plume surfaces and the dilution is low. Compliance with aesthetic standards can best be checked by field observations at the discharge site and along the shore.

Total Dissolved Gases

Several states have a limit for total dissolved gases of 110 percent of saturation. Supersaturation of dissolved gases is not considered to be a likely problem for municipal wastewater discharges to the marine environment and is not discussed further.

Chlorine Residual

Chlorine residual standards may be expressed as a concentration limit in the effluent or as a maximum concentration in the receiving water at the completion of initial dilution. If the effluent is not chlorinated, no further information is required. If the standard is expressed as an effluent limit, chlorine residual data from treatment plant operating reports, or other sources, should be presented in the application. If no data are available, then the procedure for chlorination, including the compound used, quantity, and occurrence of any operational problems, should be described. If the standard is expressed as a maximum limit at the completion of initial dilution, the concentration in the receiving water, assuming the ambient concentration is 0.0 mg/l, can be estimated as follows:

$$Cl_f = Cl_e/S_a \qquad \text{VI-40}$$

where:

Cl_f = chlorine residual at completion of initial dilution, mg/l
Cl_e = chlorine residual in effluent, mg/l
S_a = lowest flux-averaged initial dilution.

As a worst-case approach, the maximum observed chlorine residual in the effluent should be used with the lowest dilution. If violations are predicted, the applicable water quality standard may require information on the frequency of occurrence.

Nutrients

Standards can be expressed as maximum receiving water concentrations of total nitrogen or total phosphorus or as a general prohibition on amounts which would cause objectionable aquatic life. In general, for small discharges when the initial dilution is large, nutrients are not likely to cause problems. Appropriate state agencies should be contacted to ascertain if algal blooms, red tides, or other unusual biological activity have occurred near the discharge site in the past.

Receiving water and effluent nutrient data can be used to estimate concentrations at the completion of initial dilution. For screening purposes, the nutrients can be treated as conservative parameters. The concentration is estimated as follows in a similar manner to suspended solids:

$$C_f = C_a + \frac{C_e - C_a}{S_a} \qquad \text{VI-41}$$

where:

C_a = background concentration, mg/l
C_e = effluent concentration, mg/l
S_a = initial dilution (flux-averaged)
C_f = concentration at the completion of initial dilution, mg/l.

The predicted concentration can then be compared to the state standard.

Since water quality criteria are often prescribed as maximum values not to be exceeded following initial dilution, it is useful to rearrange the above equation to express the maximum allowable effluent concentration as follows:

$$(C_e)_{max} = C_a + (S_a)_{min} (C_c - C_a) \qquad \text{VI-42}$$

where:

$(C_e)_{max}$ = maximum allowable effluent concentration such that water quality criteria are not exceeded
C_c = applicable water quality criterion
$(S_a)_{min}$ = minimum expected initial dilution.

The maximum observed effluent concentration can then be compared to the predicted allowable concentration. This approach can be used for any conservative constituent. Thus, if other specific limits exist such as for color, effects due to the discharge can be determined as shown in Equations VI-41 and VI-42.

Coliform Bacteria

Standards may exist for total or fecal coliform bacteria and are usually expressed as a mean or median bacterial count and a maximum limit which cannot be exceeded by more than 10 percent of the samples. If the effluent is continuously disinfected using chlorination or an equivalent process, analyses for coliform bacteria may be needed only to verify the effectiveness of disinfection. If disinfection is done part of the year, analyses should be representative of conditions when the effluent is not so treated. The chemicals used, quantities, and frequency of use should be provided along with a discussion of the reliability of the system.

The coliform bacteria count at the completion of initial dilution due to the discharge can be estimated as follows:

$$B_f = B_e/S_a \qquad \text{VI-43}$$

where:

B_e = effluent coliform bacteria count, MPN/100 ml
S_a = initial dilution.

As a conservative approach, the maximum effluent count and the lowest initial dilution should be used. If onshore currents occur only during a particular season, the coliform count at the completion of initial dilution can be estimated using the lowest initial dilution appropriate for that season. Effluent coliform data should be submitted to support the applicant's values. The predicted value can be compared with the appropriate standard at the ZID boundary. This value can also be used to estimate the bacterial concentration at specific locations away from the ZID.

Because different limits may apply to specific areas (e.g., shellfish harvesting areas, beaches, diving areas), the maximum bacterial count at a specified distance from the discharge may be of concern. This bacterial count can be estimated in a manner analagous to the estimation of the BOD exerted as the wastefield spreads out from the ZID. The maximum bacterial count at the centerline of the wastefield can be estimated as a function of distance from the discharge as follows:

$$B_x = B_a + \frac{B_f - B_a}{D_s} \exp\left(-k \frac{X}{U}\right) \qquad \text{VI-44}$$

where:

B_x = coliform bacteria count at distance x from ZID, MPN/100 ml
B_a = ambient coliform bacteria count, MPN/100 ml
B_f = coliform bacteria count at completion of initial dilution, MPN/100 ml
D_s = dilution attained subsequent to initial dilution at distance x
k = coliform bacteria decay rate, 1/day
X = distance to desired area, m
U = current speed, m/day

when $x=0$, $B_x=B_f$. In cases where the background bacterial count is negligible or the effect of the discharge alone is desired, the terms for the ambient bacterial count can be dropped, simplifying Equation VI-44 to:

$$B_x = \frac{B_f}{D_s} \exp(-kt) \qquad \text{VI-45}$$

where:

t = travel time in days $\left(\frac{X}{U}\right)$.

and other terms are as defined previously. Values for subsequent dilution as a function of travel time and initial wastefield width for open coastal areas and large estuaries were listed in Table VI-9. Guidance is included in the Farfield Dissolved Oxygen Demand section of this document on methods for estimating subsequent dilution for sites located in narrow estuaries or bays.

The decay rate typically used for coliform bacteria is 0.5 to 1.0/day. The decay rate is influenced by water temperature, incident light, salinity, and other factors. As a conservative estimate, the minimum decay rate should be used. If no violations would occur, then further calculations are not needed. Flocculation and sedimentation can cause an apparent decrease in coliform count in the water column, but the bacteria are retained in the sediment. Thus, this process is not included in the above approach. If the applicant has information indicating that the decay rate at the discharge site should be a different value, the revised decay rate may be used. The evidence for the revised decay rate, including any data or results of laboratory tests, should be included in the application.

The estimated coliform count at the location of interest should be compared to the applicable standard. If a violation is predicted, the water quality standards may require that the approximate frequency should be discussed based on the percentage or likelihood of currents transporting the wastefield in the direction of interest.

IMPACTS ON WATER SUPPLIES AND OTHER SOURCES

Water Supplies

At the present time in the United States, there are only a few desalinization plants designed to provide potable water and most of these are used for research purposes. Table VI-12 lists desalinization plants identified through the 301(h) review process. The applicant should contact the state water quality and public health departments, any local military facilities, and local water supply departments to determine if any plants exist or are planned. If no desalinization plants or other water supply intakes exist within 16 km (10 mi) of the outfall, no analyses are required. The name of the agencies contacted and the person involved should be listed in the application.

If a water supply intake does exist, the location should be shown on a map with the discharge site marked. The travel time to the intake should be estimated using the average current speed. The applicant should show that all water quality standards are met at the intake using the methods discussed in this document.

TABLE VI-12. KNOWN DESALINIZATION PLANTS

Plant Location	Status	Purpose
Rosarito, Mexico	operating	water supply
California-American Water Company at San Diego Bay, CA	closed	water supply
Virginia Beach, VA	proposed	water supply
Santa Catalina Island, CA	operating	water supply

Other Sources

The 301(h) regulations require an analysis of whether the modified discharge would result in additional pollution control requirements on other point or nonpoint sources.

For open coastal waters, a list of pollutant sources within 3.2 km (2 mi) of the applicant's outfall will provide a reasonable scope of interest. The effect of an applicant's discharge on other sources can be estimated by estimating the total dilution at the source. The total dilution is the initial dilution times the subsequent dilution. The subsequent dilution at each outfall can be estimated using Table VI-9 in the Dissolved Oxygen Section of this document. If the effect of the applicant's outfall is small at the other source, no further analysis is needed. For most small discharges, the effects on other sources will be negligible. If not, but water quality standards are met at the other source, then increased treatment at that source would not be necessary.

In estuaries where outfalls are close together, effects on other sources are possible. A similar approach as above can be used to estimate the total dilution at the other outfalls.

VII. MARINE BIOLOGICAL ASSESSMENT

The purpose of this section is to provide guidance on appropriate methods to assess the biological effects of the discharge. Information sources, basic approaches and levels of documentation are described. The applicant is referred to the document entitled "The Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters" for specific guidance on study design, sampling procedures, and analytical techniques. In addition, sampling guidelines for demersal fishes, benthic macroinvertebrates, zooplankton, phytoplankton, and intertidal assemblages are available in the following respective EPA publications: Mearns and Allen (1978); Swartz (1978); Jacobs and Grant (1978); Stofan and Grant (1978); and Gonor and Kemp (1978).

The extent of documentation provided by the applicant in the marine biological assessment should reflect the quality and quantity of the effluent and the sensitivity of the receiving environment. Data requirements will be less for applicants without substantial industrial waste sources whose discharges into ocean waters do not potentially affect distinctive habitats of limited distribution or important fishery resources. The most technical and comprehensive documentation will be required for large discharges with substantial industrial wastes located in stressed, saline estuarine waters.

BASIC INFORMATION

Applicants are to submit certain basic descriptions of biological communities in the vicinity of the sewage outfall. EPA's regulations place special emphasis on marine communities which, because of their ecological significance or direct value to man, deserve special protection from impacts of sewage discharges. Examples of such communities include coral reefs, seagrass beds, kelp beds, rocky intertidal areas (where not common), and fish/shellfish resources of commercial or recreational importance.

In addition, large applicants are to submit descriptions of representative biological communities in the receiving water body. These descriptions will form the basis for the comparative balanced indigenous population (BIP) demonstrations. Thus, it is important that the applicant assess biological community characteristics at a minimum of four sites: within the ZID, at or immediately beyond the ZID boundary, within the expected discharge impact area outside the ZID, and at appropriate reference sites.

POTW effluent discharges have been shown to affect fishes and invertebrates of commercial or recreational importance. Of special importance are factors such as bioaccumulation of toxic substances or disease which may reduce the market acceptability of the catch or may result in potential effects in humans. Many studies have suggested a relationship between the incidence of disease in marine organisms and the effects of POTW effluents. These diseases include exophthalmia in spotfin croakers, *Roncador stearnsil*, and white seabass, *Cynoscion nobilis*; lip papilloma in white croakers, *Genyonemus lineatus*; and discoloration in halibut, *Paralichthys californucus* (Young 1964); fin erosion in fishes of the New York Bight (Mahoney et al., 1973); and fin erosion in Dover sole, *Macrostomus pacificus* (Mearns and Sherwood 1974; McDermott-Ehrlich et al., 1977). Bioaccumulation of chlorinated hydrocarbons and trace metals has been reported in marine organsisms collected near sewage outfalls off Southern California. Affected species included the Dover sole, *Microstomus pacificus*; rock crab, *Cancer anthonyi*; mussel, *Mytilus californianus*; and rock scallop, *Hinnites multirugosus* (Young et al., 1976a; Young et al., 1978; McDermott-Ehrlich et al., 1978; and McDermott et al., 1976).

Applications, at a minimum, should be based on all available data. The need for field surveys to collect additional data should be assessed by the applicant. If additional data are needed, the development of a plan of study (as suggested or required by EPA regulations, depending on when the data are to be collected) will provide an opportunity for EPA to consult with the applicant on data collection, timing, procedures, and analyses. This process will greatly reduce the potential for unnecessary field surveys and thereby maximize cost-effectiveness of data collection.

Commercial and Recreational Fisheries

Assessment of impacts on fisheries is important because of economic significance, recreational potential, and the potential for human consumption of contaminated organisms. For this assessment, the applicant should specify whether species of recreational and/or commercial importance occur in the following areas:

- In the immediate vicinity of the discharge
- In the general region of the discharge
- As migrants through the region.

The immediate vicinity of a discharge includes the outfall structure and the area which is associated with the discharge plume and/or which is clearly impacted by discharged sediment deposition. The spatial extent of fishery data will depend on the size and potential effects of the discharge and on the characteristics of the data. In general an applicant should consider fisheries occurring within areas potentially influenced by the discharge. Many state fish and game agencies have established coastal statistical areas for recording fisheries data. In this case, an applicant can consider regional fisheries as those occurring in the statistical block which includes the outfall. If an outfall is located within an embayment or estuary where fisheries occur, an applicant should address these activities throughout the coastal water body. If the applicant identifies fishery resources in the receiving water body, the distance(s) of the fishery resources from the discharge should also be provided.

If the applicant identifies fishing areas in the vicinity of the discharge, the following information should be provided:

- Magnitude of the fisheries
    a. Effort levels (e.g., number of vessels or number of fishermen)
    b. Economic value of landings or sport fishery

- Temporal pattern of the fisheries.

The applicant should also determine if any potential, unharvested fishery resources occur in the area due to warnings or closures. If unharvested resources are identified, the applicant should indicate the reason(s) why these resources are not utilized, including such aspects as:

- Health related factors (including paralytic shellfish poisoning, bacteriological contamination, and bioaccumulation of toxic substances)

- Economic or marketing considerations

- Resource protection closures

- Other regulatory closures.

If reasons for closures are due to tissue contamination, the applicant should specify the pollutant sources identified as contributing to the contaminant levels.

Many sources of information are available to address the fish and fishery concerns outlined above. Applicants should consider contacting:

1. Local fishermen

2. Public, institutional, and agency libraries

3. Academic institutions (e.g., marine science, biology, zoology departments; Sea Grant offices; cooperative fishery research units)

4. Local (e.g., conservation boards), state (e.g., fish and game departments), and federal (e.g., National Marine Fisheries Service, Fish and Wildlife Service) natural resource agencies and affiliated laboratories

5. Regional fishery management councils (contact information available from National Marine Fisheries Service)

6. State and federal environmental protection and public health agencies.

The informational needs, sources, and types of data available are summarized in Table VII-1. This is not an exhaustive listing but is meant to provide an overview of important considerations and the most likely sources and types of information which may be expected to be available for a given area.

It will be to an applicant's advantage to request specific types of information relevant to the outfall location so that an efficient review of pertinent data may be made. Therefore, an applicant should carefully design a systematic information search strategy. The applicant should also document all personal communications by requesting an affidavit from recognized authorities contacted or by completing a detailed contact report.

Two limitations are generally inherent in state compiled fisheries data. First, the data are generally at least 1 to 2 years old when summarized. Second, the landing records are summarized over relatively large statistical areas. Thus, it is difficult to describe the magnitude of a fishery in the vicinity of a particular point such as a discharge. To overcome these difficulties, larger applicants should contact the appropriate fisheries personnel who are responsible for compiling the statistics from the area which includes the discharge. In many cases, the agency will maintain field stations where fishery biologists are particularly well acquainted with the local fisheries. While these biologists may not be able to provide precise figures for the specific outfall area, a qualitative estimate of the magnitude of the fisheries may be possible. In addition, the biologists may be able to provide data which are more current than that available from summarized statistical records.

Both the natural resource agencies and the regional fishery management councils will be able to provide information on areas, seasons, and regulations for fisheries. These sources may also be called upon to suggest particular fishery experts which may provide additional information on the fish species or fisheries of interest to an applicant.

TABLE VII-1. FISH AND FISHERIES INFORMATION NEEDS, SOURCES, AND TYPES

Information Needs	Information Sources	Information Types
Background information on fish and fisheries	Libraries	Published literature, unpublished technical reports, and other "grey" literature
Characterization of fish community (species composition, distribution, abundance)	Academic institutions Natural resource agencies	Survey data
Characterization of recreational and commercial fisheries	Natural resource agencies Regional fishery councils Academic institutions	Fishing areas, seasons, and regulations Effort, catch, and value statistics
Fish health (bioaccumulation, disease, mass mortalities)	Academic institutions Natural resource agencies	Laboratory analyses, survey data, fish kill reports
Public health considerations	Environmental and public health agencies	Closures, warnings, documented incidents, laboratory analysis
Economic/marketing factors	Federal and state natural resource agencies	Fishing regulations, market demands, prices and availability

Environmental protection and public health agencies should be contacted to obtain information on fish health in the vicinity of an outfall. These agencies monitor water quality and levels of coliform bacteria in shellfish as part of a national public health program. These agencies will also provide information on paralytic shellfish poisoning (PSP) if it is known to occur in the geographic area. Depending on the distribution of fishery resources and pollutant levels in receiving waters, the agencies may also conduct laboratory studies on toxic bioaccumulation in fish species taken for human consumption. An applicant should request all available information concerning the region and immediate vicinity of the discharge and attempt to determine the discharge's contribution to any observed fish health problems with the assistance of agency personnel. A conclusion by agency personnel that the discharge is not contributing to public health problems should be documented by the applicant.

State departments of environmental protection or ecology are generally involved with recording the occurrence of fish kills within state waters. Typically, a report is filed by a departmental agent who investigated the kill, recording such information as the severity of the incident and probable cause(s). An applicant should request and review reports of relevant fish kills and document whether the discharge has been implicated in any of these incidents.

Most environmental protection and public health agencies do not routinely assess the health status of fish unless a serious problem with toxics bioaccumulation is suspected in species sought by commercial and/or recreational fishermen. Sources of information on fish disease or abnormalities include academic institutions or fisheries agencies which may have conducted fish surveys in the vicinity of an outfall.

In summary, there are a number of sources which an applicant should consider contacting to obtain information on fish and fisheries in the vicinity of a discharge. A careful review of the available information should enable a smaller applicant to characterize the local fish communities and fisheries without the need for an actual field survey unless there is sufficient evidence to indicate that the discharge has, or is likely to, adversely impact important fish resources. The applicant may also use these informational surveys to determine the kinds of field studies, if any, required to assess fish communities near the discharge.

Distinctive Habitats of Limited Distribution

Distinctive habitats of limited distribution may be highly susceptible to impacts from sewage discharges. These habitats include, but are not limited to, coral reefs, kelp beds, seagrass meadows, spawning or nursery areas for commercial species, sites of aesthetic appeal to man and rocky intertidal habitats (where they are uncommon). The relatively high sensitivity of distinctive habitats results from the potential effects of discharged suspended solids and nutrients on the unique floral (e.g., kelp, seagrass) or faunal (e.g., coral) components of the communities. Moreover, the potential for adverse effects of bioaccumulation of toxic substances is also relatively high since sessile floral and faunal organisms may constitute important trophic pathways within these communities. These attached communities are also susceptible because of the potential for continuous exposure to the effluent plume.

The scientific literature indicates that many of the distinctive habitats may be particularly sensitive to POTW discharges. Johannes (1975) identified several mechanisms through which sewage effluents have disrupted coral reefs. These include turbidity, elevated phosphate content of the water, anaerobic sediment conditions, and the stimulation of the growth of algae mats which suffocate coral. Zieman (1975) reviewed several instances in which POTW effluents have caused or contributed to the disappearance of seagrass beds. Murray and Littler (1974) found that one of the most obvious effects of a discharge on the intertidal zone was a great reduction in the normal overstory provided by brown algae and the spermatophytes. Carlisle (1969) and others have suggested that kelp may not be able to survive in areas affected by particulates from POTW discharges.

The applicant must present a general description of habitat types within the receiving water environment. Special attention should be given to the presence of distinctive habitats of limited distribution. The applicant must provide the following information regarding distinctive habitats:

- Kinds of distinctive habitats occurring in the general vicinity of the discharge

- Distribution of the habitat in the region

- Approximate distance from the discharge to potentially impacted habitats.

The basic information supplied by the applicant is expected to be descriptive in nature, and should not require field surveys. Possible sources for information on distinctive habitats include:

- Contacts with local offices of state conservation agencies

- Review of literature, especially resource maps available for many areas.

Since most distinctive habitats are visible to a surface observer, the applicant may also use direct visual observation of the marine environment in the discharge vicinity.

The primary emphasis of the applicant's discussion should be oriented towards an assessment of the potential for contact of the effluent plume with any nearby distinctive habitats. The minimum informational requirements would be associated with cases in which there are no known distinctive habitats in areas potentially affected by the discharge. If distinctive habitats are identified in the region, the applicant must indicate, using the basic assessments of effluent dilution and dispersion discussed in Chapters V and VI, the potential for significant solids deposition or localized eutrophication at the habitat sites.

In cases where a distinctive habitat occurs near a marine outfall, the applicant can evaluate impacts by considering:

- Degree of initial dilution

- Degree of farfield dispersion

- Frequency and direction of waste transport
- Lack of prior appreciable harm.

If available, additional important information which could be supplied by the applicant would include documentation of any long-term changes in spatial extent or general health of the distinctive habitat. Examples of such information would include areal extent of kelp beds or condition of algal cover on coral reefs. If historical changes in the habitat have occurred, the applicant should attempt to relate those changes to natural or pollution-related events. For example, coral reefs may be extensively damaged by severe storms, and trampling by heavy pedestrian traffic can impact rocky intertidal communities.

FIELD SURVEYS

For large discharges and for all dischargers where basic information indicates a likelihood of impact of the sewage discharge on marine biological communities, or that some impacts are already being manifested, the applicant should conduct one or more field surveys to document the extent and magnitude of such effects. The following are examples of the kinds of basic information which would indicate the need for site-specific field surveys:

1. Inadequate diffuser design or low initial dilution;
2. Poor flushing characteristics of receiving water body;
3. High concentrations of toxic substances in effluent;
4. Empirical or theoretical evidence for accumulation of discharged solids near the discharge;
5. Distinctive habitats of limited distribution or important fisheries in the discharge vicinity;
6. Observed fish kills near discharge;

7. Evidence of regional degradation of biological communities due to other pollutant sources;

8. Previously identified impacts caused by the discharge which have not been adequately characterized.

Because of the impact potential of large discharges and the previously documented effects of those discharges, it is expected that field studies of biological communities will be required in all cases to adequately assess impacts. The required data may result from past studies conducted by the applicant or from studies developed as part of the applicant's plan of study.

Surveys at Reference Sites

The BIP concept is discussed extensively in Chapter II. The demonstration of a BIP requires a comparison of biological characteristics near the discharge with those at one or more reference sites. Thus, the selection of an adequate reference site(s) forms an important aspect of field survey design.

Reference sites used for BIP demonstrations should be selected to reflect the physical and chemical characteristics which would be expected to occur at the discharge site in the absence of pollution. Those characteristics might include temperature, salinity, depth, substrate composition and hydrographic regime. Additional reference sites may be required for distinctive habitats of limited distribution, such as coral reefs, spawning grounds, seagrass beds, and kelp beds, when they occur in the discharge area. Different reference sites may be necessary for assessing each of the biological communities that may be impacted by the applicant's discharge. For example, a suitable reference site for the infaunal benthos might not be acceptable for demersal fishes. Demersal fishes are mobile and a suitable reference site must preclude the possibility that specimens collected as controls could have recently inhabited the immediate vicinity of the discharge.

Reference sites should not be subjected to ecologically significant sources of pollution. Ideally they should be totally unpolluted, but it may be impossible to locate a comparable site that has not been perturbed or contaminated to some extent by man's activities. The level of contamination at the reference site should not be sufficient to cause alterations in natural population or community characteristics.

EPA recognizes the difficulty of locating suitable reference sites for field investigations of marine pollution. Natural variations occur in the structure and function of balanced, indigenous populations. Hence, the agency does not expect applicants to demonstrate that biological conditions near the zone of initial dilution are identical to biological conditions at the reference site(s). In conducting a BIP demonstration for an ocean discharge, the applicant should compare the range of variability of biological conditions immediately beyond the ZID with the range of natural variability of biological conditions at the control site(s). Applicants with estuarine discharges should also compare the variability of within-ZID communities with the range of natural variability.

Surveys beyond the ZID

EPA recognizes that, due to logistical and navigational constraints, the applicant may not be able to collect samples immediately beyond the ZID. For discharges into water depths < 30 m, applicants may use diver-collected samples or use diver deployment of a marker buoy at the outfall location, enabling more accurate station positioning of ZID and near-ZID stations. Station positioning at deeper discharges may be more difficult because of uncertainties in discharge and vessel locations. Thus, ZID-boundary benthos or water column samples should be collected within a distance from the ZID equal to the water depth at the outfall site. If fish sampling is conducted, stations should be located within 250 m of the ZID boundary for all outfall depths. ZID-boundary sampling stations should be located at the same depth as the discharge. Applicants supplying biological data collected prior to these guidelines should supply information on biological communities located as close as possible to the ZID.

Additional biological surveys should be conducted where currents or other factors cause an accumulation of effluent components (in the water column or on the seabed) away from the boundary of the ZID. Results of solids deposition analyses will be important for determining the need for additional survey sites in areas of potential discharge-related impact beyond the ZID.

The survey design should enable detection of substantial variation in environmental conditions when this occurs near the ZID. If distinctive habitats of limited distribution are likely to be exposed to the applicant's discharge, additional sampling should be conducted at both the exposed habitat and at appropriate reference sites.

In assessing the marine communities near the ZID in relation to control communities, the applicant should provide several descriptive biological characteristics rather than relying on a single characteristic. Community characteristics to be described by the applicant shall include, but not be limited to, species composition, abundance, dominance, diversity, spatial/temporal distribution, trophic structure, and presence of indicator species. The variability of each biological characteristic at the reference area(s) should be compared with its variability near the discharge. However, the assessment of the presence or absence of a BIP should not only involve these individual comparisons, but should be conducted by an overall consideration of the integrated characteristics of all communities studied.

Surveys within the ZID

Applicants are to assess biological conditions within the ZID. Within-ZID surveys may be supplemented by other available data (e.g., from other comparable discharges) to characterize biological assemblages within the ZID or to predict response of those communities. Such data will be considered in evaluating compliance with within-ZID biological requirements or the need for additional data collections. Certain major environmental perturbations within the ZID are unacceptable. These include, but are not limited to, the destruction of distinctive habitats of limited distribution (e.g., coral reefs, nursery and spawning grounds, and shellfish, grass and kelp beds); the presence of disease epicenters (fin rot, liver hematoma, lesions of fish and shellfish, or other pathogenic micro-organisms which present potential hazards to human health); the occurrence of mass mortalities of marine organisms; or unacceptable accumulation of toxic substances in commercially or recreationally harvestable fish and shellfish.

Biological Communities Sampled

In determining presence or absence of a BIP the applicant may consider several biological community types such as demersal or pelagic fishes, benthic macroinvertebrates, phytoplankton, zooplankton, macroalgae, and intertidal assemblages. An extensive analysis of each of these communities will not usually be necessary; however, the applicant is to provide a rationale for the selection of communities to be examined. If one or more of the aforementioned communities are found, or are expected, to be affected by the applicant's discharge, the applicant is encouraged to assess other communities to provide a more comprehensive evaluation of overall biological conditions near the outfall. As a minimum, an applicant should generally assess impacts on benthic communities such as infaunal and epifaunal macroinvertebrates and demersal fishes. The following sections provide general study design considerations for major community types. The applicant is referred to "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters" for specific field sampling program guidance.

BENTHIC MACROINVERTEBRATES

The macrofaunal benthos will often provide an appropriate assemblage for assessing impacts of a discharge. Benthic animals tend to be relatively long-lived, permanent residents of an area. They are sensitive to both sediment and bottom water quality and reflect the integrated effects of long-term environmental conditions.

For discharges of primarily domestic wastes, the potential impacts on benthic organisms result mainly from an accumulation of organic material in the sediments near the outfall. The enrichment of sediments by organic wastes can modify the normal trophic structure of benthic communities (e.g., change from suspension feeders to deposit feeders). Moreover, high deposition rates can cause anoxic surficial sediments, resulting in communities dominated by pollution-tolerant species.

Benthic surveys should be designed to assess the intensity and spatial extent of community changes attributable to the applicant's discharge. They should also yield data which are adequate to perform valid statistical and community analyses. To meet these objectives, general guidelines are suggested below.

Benthic stations should be occupied in both nearfield and farfield areas of the receiving environment. Nearfield and farfield areas may be determined from results of the suspended solids deposition analysis. In general, two or more stations should be occupied in the immediate discharge area (i.e., within and near the ZID), and two or more stations should be occupied beyond the immediate discharge area but within the region influenced by POTW effluent. The total number and locations of the benthic survey stations should reflect the size of the discharge, the hydrography of the receiving environment, and the projected area of maximum suspended solids deposition. The greater the projected area of impact, the greater the number of stations which should be occupied.

Each applicant conducting a benthic survey should also occupy one or more control stations in an area similar to that of the discharge, but unaffected by pollutants from any anthropogenic sources. These sites will provide baseline data on community structure and function in the absence of all pollutant stresses. Proper selection of these sites is critical to meeting the objectives of the benthic survey.

Applicant's discharging into stressed waters should also occupy one or more stressed control sites. Benthic conditions at these sites should reflect ambient stresses in the receiving environment which are not specifically attributable to the applicant's discharge. Data from these sites will be used to determine whether or not the applicant's discharge contributes to, or perpetuates, alterations of benthic community structure and function in addition to those generated by ambient levels of stress. As with unstressed control sites, proper selection of these site(s) is critical to meeting the objectives of the benthic survey.

Data collected during a benthic survey should include abundance estimates for all dominant taxa at each site, and biomass estimates for each site. These data should be adequate to perform valid statistical and community analyses for the purposes of determining whether or not:

1. Benthic community structure in the discharge area differs from that in the control area

2. Benthic biomass in the discharge area differs from that in the control area

3. Opportunistic or pollution-tolerant species dominate benthic communities in the discharge area

4. Anoxic sediment conditions occur in the discharge area

5. Distinctive habitats of limited distribution (when present) are adversely affected by the applicant's discharge

6. The applicant's discharge contributes to, or perpetuates, ambient stresses in the receiving environment (stressed water discharges only).

Structural characteristics of benthic communities can provide adequate evidence of effluent impacts. These characteristics include densities and biomass of individual species, species richness, dominance, diversity, and spatial distribution patterns. The distribution of indicator species known to be particularly tolerant or sensitive to sewage-related perturbations should be emphasized since such characteristics form an important component of a BIP. The dominance of pollution-resistant or opportunistic species such as capitellid polychaetes may increase in disrupted marine habitats. Such species are rarely dominant under natural, unstressed marine conditions. Thus, the applicant should compare the abundances of such species at the reference site(s) and at sites located just beyond the ZID. The applicant should consult Word et al. (1977) and Pearson and Rosenberg (1978) for examples of indicator species.

When the applicant's discharge is located in an area exhibiting soft substrates, sediment data must also be collected simultaneously at each sampling site. These data should include grain size composition and a measure of organic content. Data on Kjeldahl nitrogen, sediment BOD, and other sediment parameters may also be collected. Sediment data will be used to determine whether or not correlations exist between benthic community structure and attributes of the sedimentary environment in the receiving waters.

FISHES

Sewage discharges have been demonstrated to influence demersal fish communities at discharge locations. Observed responses include changes in abundance and increases in disease prevalence.

Alterations in fish abundance may be due to a number of factors. Many outfall pipes are located in sandy or muddy areas where the structural components of the outfall provide an artificial reef for species which might not normally occur in the region. Demersal fishes (e.g., flounder, sole) are susceptible to impact from POTW discharges due to their limited mobility (compared to pelagic fishes) and direct physical contact with bottom sediments. Demersal fishes also have preferences for specific substrate types and may either be attracted to, or avoid, sediments enriched with discharged organic material. Demersal fishes may respond to the same potential substrate-related effects of POTW discharges as would benthic macroinvertebrates, or they may respond to changes in benthic infaunal communities (e.g., food availability). Due to the inherent difficulties in assessing distributional effects on fishes, such studies should be considered as secondary to studies of benthic macroinvertebrates in cases where basic data indicates the need for field surveys. Thus, the results of benthic macroinvertebrate studies may be used as an indication of the need for additional surveys of fishes. The following effects manifested in the benthos indicate the need for fish surveys:

- Significant reductions in the biomass of benthic organisms
- Reduced or increased abundances of important fish food organisms (e.g., amphipods)
- Bioaccumulation of toxic substances in important fish food organisms.

The following are additional considerations which should be used to evaluate the need for fish surveys:

- The extent of commercial or recreational fish resources in the immediate vicinity of the discharge

- The occurrence of fisheries for these resources in the immediate vicinity of the discharge

- The potential for bioaccumulation of toxic substances commercial or recreational fish or invertebrate species

- The occurrence of disease, abnormalities, or mass mortalities in commercial or recreational species in the immediate vicinity of the discharge.

EPA regulations require applicants to address the occurrence and value of commercial and recreational fisheries in the outfall area. The potential for bioaccumulation of toxic substances should also be considered. As discussed above, the potential for bioaccumulation varies depending upon the species which inhabit the area. Pelagic and diadromous fishes have a low probability of risk since populations of these species are transient in nature. Shellfish and demersal fishes are less mobile and remain in virtually continuous contact with sediments. Thus, demersal species are considerably more susceptible to contamination from polluted sediments than are pelagic species. Therefore, if demersal and shellfish species are exploited in the immediate vicinity of an outfall where bioaccumulation is likely to occur (as evidenced by contamination of sediments or benthos), a field survey should be conducted.

BIOACCUMULATION

The discharge of sewage effluents containing toxic substances can result in bioaccumulation, especially in areas of organic sediment accumulation. The two general categories of substances with the highest potential for bioaccumulation in marine organisms are toxic heavy metals and persistent synthetic organic compounds. The identification of substantial concentrations of such substances in the plant effluent in combination with either of the following receiving water characteristics indicates the need for evaluation of bioaccumulation:

1. Evidence of effluent transport towards areas utilized for shellfish harvesting

2. Significant occurrence of important recreational or commercial species and evidence of potential sediment accumulation in the outfall vicinity.

The potential for bioaccumulation may be evaluated by the applicant by comparing the concentrations of toxic substances after initial dilution with EPA saltwater criteria. Two types of information are required for this comparison:

1. Concentration of the pollutant in the discharged effluent

2. Critical initial dilution.

The value of (1) divided by (2) should then be compared with the available criteria value.

Most of the toxic substances with a high bioaccumulation potential will be associated with organic particulates in the discharged effluent. Thus, in determining bioaccumulation potential, it is important not only to evaluate concentrations of these substances in the effluent and in the receiving water following initial dilution, but also to examine sediment accumulation patterns. For such substances, water quality criteria may be met, but significant bioaccumulation can potentially occur due to localized accumulation of contaminated sediments. Alternatively, the applicant may be able to demonstrate that bioaccumulation is not a serious problem, even though toxic substances are present in the effluent, by providing information demonstrating:

- Adequate initial dilution

- Sufficient circulation to prevent localized accumulation of solids or trapping of effluent plumes.

The degree to which the applicant may be required to assess bioaccumulation using field surveys is also dependent upon the kinds of organisms present. Several studies have demonstrated the ability of bivalve molluscs and crustaceans to accumulate metals and organic substances near sewage discharges (Young et al., 1976b; Young et al., 1978). Studies at some of the same sites and at other contaminated areas have indicated that demersal marine fishes do not generally accumulate metals in muscle tissue (with the exception of organic mercury) but accumulate organic substances such as high molecular weight chlorinated hydrocarbons (McDermott-Ehrlich et al., 1978; McDermott et al., 1976). Thus, in cases where an effluent has significant levels of heavy metals, the potential data requirements would be greater if shellfish resources occurred in potentially impacted areas than if fishes constituted the only locally important resources. Furthermore, the potential for bioaccumulation would be less if fishes with only transitory plume exposure were present (e.g., pelagic or migratory species) than if demersal species dominated in areas of sediment deposition.

Sessile filter-feeding molluscs which are highly susceptible to bioaccumulation, and which may also be important commercial or recreational resources, are generally found in near-shore habitats, especially in embayments or estuaries. If an applicant can demonstrate that shellfish resources do not occur in the outfall vicinity or in other areas potentially impacted by the discharge, and/or that effluent dispersion is adequate, tissue analyses of indigenous biota may not be required to demonstrate the absence of adverse bioaccumulation. Discharges located in areas with limited dispersion, such as estuaries or embayments, may cause contamination of local shellfish resources. In such cases, the applicant should conduct analyses of tissue concentrations of toxic substances identified in the plant effluent. Examples of species which may be appropriate for tissue analyses include oysters, clams, mussels, crabs, or lobsters. An additional situation which will influence the requirement for direct assessment of bioaccumulation is where other pollutant sources cause observed contamination of fish or shellfish resources. This would especially pertain to cases of nearby fishery closures or harvesting restrictions due to pollutant inputs. In such cases it is important for the applicant to demonstrate that its discharge is not contributing to the existing contamination. This demonstration can be accomplished by the previously described analyses of effluent pollutant concentrations and initial dilutions, or by evaluation of existing information on the spatial patterns of pollutant concentrations in organisms or sediments. It may be necessary for the applicant to conduct tissue or sediment analyses if effluent and dilution analyses indicate the potential for bioaccumulation and sufficient data are not available to determine pollutant sources in areas of existing contamination of fishery resources.

PLANKTON

Plankton are, by their very nature, transient and not permanent residents of an area. Hence, it is less likely that plankton will undergo severe adverse impacts of sewage discharge than for certain other biotic groups. Phytoplankton are more likely to be adversely affected than are zooplankton.

The most likely direct effect of sewage effluent on phytoplankton communities is enhancement or inhibition of primary production. Enhancement may occur in areas where the phytoplankton are naturally nutrient limited, since sewage effluent may represent a significant source of nutrients. Inhibition may occur if there are sufficient concentrations of toxic or inhibitory substances in the effluent.

Relatively minor enhancement of phytoplankton primary production may be viewed as a beneficial effect, since it may lead towards increased production at higher trophic levels. More extensive stimulation of algal production may contribute to eutrophication of the receiving water body, however, and an overabundance of phytoplankton may cause depletion of dissolved oxygen upon decomposition of the algae. Dissolved oxygen deficiencies may be responsible for fish kills or the deaths of other marine organisms. Conditions contributing to severe eutrophication might include the following:

- Discharge of sewage effluent into oligotrophic waters
- Inadequate initial dilution
- Re-entrainment of the diluted effluent into the effluent plume

- Poor flushing of the receiving water body.

Dissolved oxygen deficiencies may also result from decomposition of the organic matter contained in sewage. Numerous fish kills have occurred which can be attributed to eutrophication and/or decomposition of the organic matter contained in sewage (Tsai 1975).

An applicant may be able to demonstrate that adverse eutrophication of the receiving water body is not occurring, or will not occur, by providing information demonstrating:

- Degree of initial dilution
- Sufficient circulation to provide flushing of the receiving water body and to prevent re-entrainment of the effluent plume
- Absence of evidence suggesting kills of fishes or other organisms
- Adequate dissolved oxygen concentrations in the receiving water body.

These demonstrations would generally not require field surveys and are discussed as basic informational requirements in the preceding sections.

If there is evidence of dissolved oxygen deficiencies and/or fish kills in the local area, the applicant may be able to demonstrate that eutrophication is not the cause. If phytoplankton production is greatly enhanced, the standing stock of phytoplankton may be expected to be higher than in reference areas. Measurement of chlorophyll a concentrations is an indirect method of estimating the standing stock of phytoplankton. The applicant may demonstrate that chlorophyll a concentrations in the general vicinity of the outfall are not significantly higher than those in appropriate reference areas. If this is the case, dissolved oxygen deficiencies and/or fish kills may be due to other causes (e.g., high BOD levels in the sewage effluent or other pollutant sources in the area).

In situations where field surveys of phytoplankton are indicated, the applicant may assess standing stock (chlorophyll a), species composition, or primary production (^{14}C light-dark bottle technique). The measurement of primary production is more complicated and subject to varying interpretations. Since the ecological consequences of small-scale changes in production as measured by available techniques are obscure, the applicant should consider standing stock measurements and taxonomic analyses of phytoplankton communities as constituents of a basic phytoplankton survey. Measurements of primary production would serve as supplementary studies, especially in cases of very large discharges into sensitive receiving environments.

While many alterations in phytoplankton community composition would not have drastic ecological effects, one such alteration is of considerable concern. Toxic dinoflagellate species occasionally bloom in some geographic areas, resulting in the closure of fisheries for some shellfish due to the possibility of paralytic shellfish poisoning (PSP). While conclusive evidence is lacking, there have been suggestions that the nutrients contained in POTW effluents may stimulate such blooms [cf. Tsai (1975); Doig and Martin (1974); Dunstan and Menzel (1971)]. Consequently, the applicant should document historic occurrences of toxic dinoflagellate blooms in the vicinity of the outfall. Local health department officials may provide information on PSP-related closures of shellfishing grounds in the area.

For zooplankton, there is not likely to be a direct functional response to the discharge of sewage effluents similar to the enhancement or inhibition of phytoplankton primary production. Toxic effects of sewage effluent on zooplankton are possible if there are sufficient concentrations of toxic substances in the effluent. Alteration of zooplankton community composition is a distinct possibility in areas where the phytoplankton community composition has been affected, since many zooplankton graze on phytoplankton. Given the smaller proportion of their life spans spent within the sphere of influence of the discharge, zooplankton are less likely to experience changes in community composition than are phytoplankton.

Zooplankton typically have highly variable distributions (Jacobs and Grant 1978), requiring numerous samples over closely spaced intervals of space and time to achieve precise estimates of abundance. Zooplankton are also subject to significant, natural variations in abundance and species composition, requiring collection of samples at intervals throughout the entire year. Taxonomic analysis of these samples is time consuming and costly, and it requires the services of a competent zooplankton taxonomist.

Discharge-related alterations in zooplankton community composition are not only less likely to occur than are changes among the phytoplankton, but they are also less likely to have drastic ecological effects. Alterations in zooplankton community composition could have effects on organisms at higher trophic levels, many of which feed either directly or indirectly on zooplankton, but considering the localized nature of any possible effects on zooplankton, the possibility of such higher level effects is relatively remote. Thus, conducting zooplankton field surveys should always be considered secondary to phytoplankton surveys.

VIII. TOXIC SUBSTANCE CONTROL PROGRAMS

The toxics control program is designed to identify and assure control of toxic pollutants and pesticides discharged to the POTW. The section 301(h) toxic control regulations require both industrial and nonindustrial source control programs. However, the control of industrial sources is separately addressed by pretreatment program regulations [40 CFR Section 403.8(d)] that require all industrial pretreatment programs to be approved by July 1, 1983. The concern of section 301(h) with regard to industrial pretreatment is therefore that applicants adhere to section 403 program requirements and compliance schedules.

EPA's section 301(h) toxics control program regulations apply to all applicants. However, small applicants who certify that there are no known or suspected sources of toxic pollutants and pesticides to the POTW are relieved of most of the cost burden for toxic control program development.

CHEMICAL ANALYSIS

Toxic pollutants and pesticides are defined in 125.58(u) and (m), respectively, and include those compounds listed in Table VIII-1. Analytical procedures described in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA 1977) and Federal Register, December 3, 1979 (pages 69464-69575) must be followed. Additional guidance for sampling and analysis is contained in "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters."

EPA's regulations require applicants to submit results of wet- and dry-weather analyses of the treatment plant effluent. If available, influent data would also be helpful. If historic data are available, they should be presented as well. Results of the analyses should be tabulated in a summary form to allow an evaluation of the toxic quality of the discharge. The applicant should describe the sampling effort by describing the

TABLE VIII-1. TOXIC POLLUTANTS AND PESTICIDES AS DEFINED IN 125.58(u) and (m)

Pesticides

Demeton
Guthion
Malathion
Methoxychlor
Mirex
Parathion

Toxic Pollutants

1. Acenaphthene
2. Acrolein
3. Acrylonitrile
4. Aldrin/Dieldrin
5. Antimony and compounds
6. Arsenic and compounds
7. Asbestos
8. Benzene
9. Benzidine
10. Beryllium and compounds
11. Cadmium and compounds
12. Carbon tetrachloride
13. Chlordane (technical mixture and metabolites)
14. Chlorinated benzenes (other than dichlorobenzenes)
15. Chlorinated ethanes (including 1,2-dichloroethane, 1,1,1-trichloroethane, and hexachloroethane)
16. Chloroalkyl ethers[a] (chloromethyl, chloroethyl, and mixed ethers)
17. Chlorinated naphthalene
18. Chlorinated phenols (other than those listed elsewhere; includes trichlorophenols and chlorinated cresols)
19. Chloroform
20. 2-chlorophenol
21. Chromium and compounds
22. Copper and compounds
23. Cyanides
24. DDT and metabolites
25. Dichlorobenzenes (1,2-, 1,3-, and 1,4-dichlorobenzenes)
26. Dichlorobenzidine
27. Dichloroethylenes (1,1- and 1,2-dichloroethylene)
28. 2,4-dichlorophenol

TABLE VIII-1. (Continued).

29. Dichloropropane and dichloropropene
30. 2,4-dimethylphenol
31. Dinitrotoluene
32. Diphenylhydrazine
33. Endosulfan and metabolites
34. Endrin and metabolites
35. Ethylbenzene
36. Fluoranthene
37. Haloethers (other than those listed elsewhere; includes chlorophenylphenyl ethers, bromophenylphenyl ether, bis(dichloroisopropyl) ether, bis-(chloroethoxy) methane and polychlorinated diphenyl ethers)
38. Halomethanes[b] (other than those listed elsewhere; includes methylene chloride, methylchloride, methylbromide, bromoform, and dichlorobromomethane)
39. Heptachlor and metabolites
40. Hexachlorobutadiene
41. Hexachlorocyclohexane
42. Hexachlorocyclopentadiene
43. Isophorone
44. Lead and compounds
45. Mercury and compounds
46. Naphthalene
47. Nickel and compounds
48. Nitrobenzene
49. Nitrophenols (including 2,4-dinitrophenol, dinitrocresol)
50. Nitrosamines
51. Pentachlorophenol
52. Phenol
53. Phthalate esters
54. Polychlorinated biphenyls (PCBs)
55. Polynuclear aromatic hydrocarbons (including benzanthracenes, benzopyrenes, benzofluoranthene, chrysenes, dibenzanthracenes, and indenopyrenes)
56. Selenium and compounds
57. Silver and compounds
58. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)
59. Tetrachloroethylene
60. Thallium and compounds
61. Toluene
62. Toxaphene
63. Trichloroethylene
64. Vinyl chloride
65. Zinc and compounds

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[a] Bis (chloromethyl) ether was removed from the toxic pollutant list (U.S. EPA 1981a).

[b] Dichlorodifluoromethane and trichlorofluoromethane were removed from the toxic pollutant list (U.S. EPA 1981b).

procedures for collecting, compositing, and preserving the samples. The number of grab samples taken for volatile organics analysis should be included in the discussion.

Rainfall data submitted for at least 5 days preceding the sampling will confirm wet or dry conditions at the time of sampling. Past analyses (Feiler 1980) have shown toxics concentrations to be significantly higher during Monday through Friday as opposed to Saturday and Sunday. It is therefore recommended that composite effluent samples not be collected on weekends unless it can be shown that another sampling period is more representative.

Analytical methods should be discussed, with appropriate references to published analytical procedures. The identity of the analytical laboratory should be given. Quality assurance procedures used on the analysis should be summarized, and results presented for review. Differences between the wet- and dry-weather analysis should be explained, if possible. Also, a comparison with past results could be made.

Sources of detected toxic pollutants must be identified and, to the extent practicable, categorized according to industrial and nonindustrial origins. The purpose of this identification and categorization is to provide a useful reference for toxics monitoring and source controls. If the applicant recognizes that the source list requires improvement, procedures to accomplish this should be described. In-system sampling and analysis, industrial discharge analysis, permit data, and site inspections could yield quantitative information as to sources of identified priority pollutants.

INDUSTRIAL PRETREATMENT PROGRAM

In this section the applicant should clearly present the history of compliance with the section 403 industrial pretreatment program. If such a program has already been approved by EPA it is necessary to indicate only the date of approval. If the program has not been approved, a schedule of activities, including the expected date of submittal to EPA, leading to section 403 compliance must be provided.

NONINDUSTRIAL SOURCE CONTROL PROGRAM

The purpose of nonindustrial source control programs is to identify the specific nonindustrial sources of priority pollutants and pesticides and then to develop specific means for their control. All large dischargers must address this requirement as well as small dischargers with known or suspected water quality, sediment accumulation, or biological problems associated with toxic pollutants or pesticides. To properly address these requirements, the applicant should describe current programs or present a schedule and description of proposed programs designed to identify and control nonindustrial sources of toxic pollutants and pesticides. At a minimum, all applicants must develop a public education program designed to limit nonindustrial sources. This may include preparation of newspaper articles, posters, or radio and television announcements designed to increase public awareness of the need for proper disposal of waste oils, solvents, herbicides, pesticides, and other substances containing toxic pollutants and pesticides.

Activities to identify nonindustrial sources could include literature searches, in-system sampling and analysis, research on nonindustrial products commonly released to the sewer, and pooling of information with other POTW operators having a similar mix of users.

There are no clearly defined rules to determine the level of effort which an applicant should apply to identify nonindustrial sources. This level of effort is expected to be directly related to the size of the discharger, however. For example, dischargers with diverse land uses within the service area may find it necessary to perform in-system sampling and analysis to explain the occurrence of toxic pollutants and pesticides.

Concentrations of pollutants within the system not accounted for by industrial sources are generally attributable to nonindustrial sources. Applicants should therefore be careful not to duplicate any in-system sampling efforts performed for compliance with industrial pretreatment regulations.

Extensive control measures may be necessary where nonindustrial sources produce concentrations of toxic pollutants and pesticides within 50 percent or more of the receiving water criteria after initial dilution. These measures could include control of the sale, use, handling, and disposal stages of substances containing priority pollutants and pesticides.

EPA recognizes the serious potential for adverse effects on marine organisms and man from bioaccumulation of discharged toxic pollutants and pesticides. EPA also recognizes the potential complexity of nonindustrial control programs. Therefore, applicants are encouraged to consult with EPA during development of nonindustrial control programs. EPA regulations state that proposed nonindustrial source control programs are subject to review and revision by EPA prior to issuing a section 301(h) modified permit and during the term of any such permit.

IX. MONITORING PROGRAMS

The extent of an applicant's monitoring program required as part of a section 301(h) variance will depend upon the characteristics of the discharge and the receiving water body. Monitoring of the effluent and receiving water may also be required as part of the applicant's existing NPDES permit or to meet state regulations. The applicant's proposed monitoring program must be submitted with the section 301(h) application. A separate document entitled "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters" provides detailed guidance on the design of section 301(h) monitoring programs.

The applicant must provide information on available personnel, facilities, and financial resources to show that the proposed monitoring program can be implemented and continued for the term of the modified discharge permit if a section 301(h) variance is granted. State monitoring requirements should be reviewed to ensure that the proposed program meets those requirements.

The following information must be provided for all portions of the proposed monitoring program:

- Variables to be measured
- Sampling methods
- Sampling schedule
- Sampling location
- Analytical techniques
- Quality control and verification procedures.

TREATMENT PLANT/EFFLUENT MONITORING

The major objectives of treatment plant monitoring are to provide data for determining compliance with permit effluent limitations and state requirements, to measure the effectiveness of the toxic substance control program, and to relate discharge characteristics to the receiving water biological and water quality conditions. In addition, influent and effluent monitoring provide data for assessment of treatment plant performance as may be required to meet modified discharge permit conditions.

Variables which should be measured in the effluent are flow, BOD_5, suspended solids, pH, dissolved oxygen, and the toxic pollutants and pesticides present or likely to be present in the discharge. The toxic pollutants and pesticides which should be measured are specified in the section 301(h) regulations in section 125.58(u) and (m). Additional variables which may be required by other permit conditions include grease and oil, settleable solids, nutrients, total and fecal coliform bacteria, and temperature.

Influent samples for conventional pollutant and nutrient analyses, if required, should be collected just downstream of any coarse screens or grit chambers. Effluent samples should be collected downstream of any chlorination or disinfection units. Samples for toxic substances should be collected in the effluent just prior to entering the outfall. In general, grab samples should be taken for pH and total and fecal coliform bacteria. For the other conventional pollutants (e.g., suspended solids), 24-hour flow-composite samples are recommended.

The analytical methods to be used for each variable should be described and the laboratory to perform the work identified. The laboratory must be state certified according to U.S. EPA-approved procedures. Quality control procedures should be provided stating the type and frequency of quality control analyses to be conducted.

WATER QUALITY MONITORING

The objectives of the water quality monitoring program are to provide data for determining compliance with applicable water quality standards to measure the presence of toxics identified or expected in the effluent, and to assist in the evaluation of biological data.

The water quality variables which may be measured are dissolved oxygen, BOD_5, suspended solids, pH, temperature, salinity, and light transmittance. Light transmittance standards may be specified in terms of turbidity, Secchi disc depth, extinction coefficient, or percent light transmittance. With the exception of Secchi disc depth, water column profiles should be determined for these variables. Other variables which may be measured include nitrogen (nitrate, nitrite, total Kjeldahl nitrogen, and ammonia), total and reactive phosphorus, chlorophyll a, floating particulates, color, settleable solids, and total and fecal coliform bacteria. Samples for these variables should be collected 1 m (3.3 ft) below the water surface, at mid-depth, and 1 m (3.3 ft) above the bottom. Sampling for toxic pollutants and pesticides should also be assessed. In deep water, additional water column sampling may be required. The applicant's monitoring program should state for which parameters profiles are to be taken along with the sampling interval and the sampling depths for the other parameters.

Station locations should include sampling at the ZID boundary, at control sites, and in potential impact areas (e.g., in the nearshore zone and close to areas with distinctive habitats). The applicant should use information on local currents and wastefield dispersion patterns in selecting sampling station locations in potentially impacted areas. Sampling stations located at the ZID boundary and at control sites should be in approximately the same depth of water and at about the same distance from shore. Control stations should be located in areas not influenced by the applicant's discharge or by other pollutant sources. For discharges involving outfall relocation, monitoring stations must be located at the current discharge site until cessation of discharge and at the relocation site. The applicant should include a map showing the location of the outfall, the shoreline, any distinctive habitats, and all sampling stations. The latitude and longitude and depths of the stations should be specified.

Sampling frequencies should be selected to comply with state requirements and to provide data for critical periods. In most cases, quarterly surveys which include the critical periods (e.g., time of maximum stratification) should meet state requirements. More frequent sampling (for coliform bacteria) may be required by states in swimming or shellfishery areas. The analytical methods should be selected from the EPA-approved methods listed in 40 CFR Part 136. Quality control/quality assurance procedures should be described.

The applicant must demonstrate that adequate resources are available to implement the program. This can be demonstrated by estimating the cost of the monitoring program and showing that adequate funds, personnel, and facilities are available.

BIOLOGICAL MONITORING

The applicant's biological monitoring program must include to the extent practicable:

1. Periodic surveys of control sites and biological communities most likely to be affected by the discharge
2. Periodic bioaccumulation determination and examination of adverse effects of effluent-related toxic substances
3. Sampling of sediments
4. Periodic assessment of commercial or recreational fisheries (if present).

Small applicants are not subject to items 2 through 4 immediately above if they discharge at depths greater than 10 meters and demonstrate through a suspended solids deposition analysis that there will be negligible seabed accumulation in the vicinity of the modified discharge.

Objectives of the biological monitoring program are to evaluate the impact of the applicant's modified discharge and to demonstrate compliance with section 301(h) biological requirements. Thus, the biological monitoring program must enable the same spatial comparisons (i.e., ZID, ZID boundary, discharge impact area, and control) as are required for demonstration of a BIP.

The applicant's monitoring program should include only those study elements which are practicable and appropriate in the receiving water environment. In cases where the applicant considers that one or more of the aforementioned study types is not practicable, a justification for their proposed deletion from the monitoring program should be provided. Examples of situations in which reductions in the frequency or extent of biological surveys would be reasonable might include conditions of high current speeds or adverse climatic periods (sampling not practicable) and periods of low biological variability or extremely low productivity (sampling not appropriate).

Monitoring program specifications supplied by the applicant must include: biological groups to be sampled, sampling methods, station locations, sampling schedules, preservation techniques, analytical techniques, quality assurance/quality control procedures, statistical analyses, and taxonomic sources.

In selecting biological communities to be sampled on a periodic basis, the applicant should consider the potential effects of the discharge and the characteristics of indigenous biota. If past studies have demonstrated discharge effects on a particular biological group, the applicant should include continued sampling of that group in the monitoring program. Monitoring must also include any distinctive habitats of limited distribution located in areas potentially affected by the discharge.

The three types of sampling stations which should generally be included in the periodic biological surveys to the extent practicable are:

- In the vicinity of the ZID
- Other areas of potential discharge impact
- Control.

Variable numbers of monitoring locations at intermediate sites between control and outfall locations should be included, especially in the case of large discharges where definition of the spatial extent of biological effects is an important consideration. Additional station requirements would also be associated with discharges into estuaries (within-ZID station) stressed waters or in situations where other pollutant sources potentially affect biological communities near the discharge. For modified discharges involving outfall relocation, monitoring must be conducted at the current discharge site until cessation of discharge and at the relocation site.

Selection of control stations is one of the more important aspects of monitoring program design since BIP comparisons will rely on data from these sites. Control stations should be located in areas not influenced by the applicant's discharge or other pollutant sources. Sediment characteristics at the control station should be similar to those expected to occur naturally in the vicinity of the discharge. Discharge and control stations should be located at similar water depths.

Bioaccumulation determinations are to be included in the monitoring program to evaluate the potential adverse effects of toxic substances. *In situ* bioassays may be needed on a case-by-case basis. Caged specimens of bivalve molluscs (e.g., *Mytilus edulis* or *M. californianus*) are recommended as test organisms for *in situ* bioassays. Exposures should be conducted in the discharge vicinity and at an appropriate reference site. Additional exposure sites may be necessary for large discharges, especially in situations where other pollutant sources contribute toxic substances to the receiving water body. Only those toxic pollutants and pesticides identified in the applicant's discharge need to be measured in the exposed organisms.

The monitoring program must also include sediment sampling for toxic substances in the vicinity of the discharge, in other areas of expected solids accumulation, and at appropriate reference sites. Within-ZID sampling should be undertaken where practicable. The sediment sampling is intended to provide an indication of the toxics accumulation within sediments near the discharge and the associated contamination potential. If elevated or increasing concentrations of toxic substances are detected, the applicant must also analyze tissue concentrations of toxic substances in indigenous organisms to determine if adverse bioaccumulation is occurring. Recommended organisms for such analyses include demersal fishes (e.g., flounder or sole), epibenthic mega-invertebrates (e.g., crabs or lobster) or sessile filter-feeding organisms (e.g., clams, mussels, or oysters).

Sediment samples should also be analyzed for characteristics which would provide support for the water quality and biological surveys. The variables of importance are associated with indicators of organic enrichment of the sediments due to accumulation of discharged solids. These variables should include particle size distribution and total volatile solids. Other variables such as BOD_5, sulfides, and total organic carbon, may also be useful and may be required by states.

If recreational or commercial fisheries are present in areas potentially affected by the discharge, the applicant must also conduct periodic assessments of those fisheries. The kinds of evaluations conducted will depend on the nature of the local fisheries and on the level of detail in available fisheries data. These evaluations must reflect an understanding of the potential impacts of the discharge on the fisheries. Sources of information used to determine the productivity and status of fisheries include discussions with state resource agencies, voluntary logbooks, interviews, and field observations. The periodicity and level of effort of fishery surveys will depend upon the size and location of the discharge, concentrations of toxic substances in the effluent, species harvested, and the importance of the commercial or recreational fishery.

X. PLAN OF STUDY

The purpose of the plan of study is to assure that data collection efforts by the applicant are designed to collect only those data necessary for decision-making purposes. In evaluation of final (1979) applications, several cases were noted where data collection efforts were beyond those ultimately required for decision making on the variance request. Other cases were noted where inappropriate methods were used, sampling stations were not properly located, data were not properly analyzed, or insufficient data were collected. Problems such as these can lead to unnecessary cost to the applicant and delays in evaluation of the applications. If existing data are not adequate, the applicant is encouraged to develop a plan of study, consult with EPA, collect the necessary data, and submit the results with the application prior to the December 29, 1982, deadline. After the deadline, applicants are required by EPA regulations to submit plans of study to EPA for consultation prior to collection of additional data to support an application or revision. Such data collection after the December 29, 1982, deadline can be done only as authorized or requested by EPA.

A plan of study should consist of four parts to describe:

- What data are needed and why
- Where and how frequently the data or samples will be collected
- Proposed data collection and sampling methods
- How the data will be analyzed.

This approach to the plan of study is applicable to all data collection activities including influent, effluent, water quality, receiving water, or biological data. The applicant should be as specific as possible in describing the proposed data collection program. A diagram showing the location of sampling stations in relation to the existing and/or proposed outfall and shoreline should be included. Specific types of sampling equipment should be identified. The number of split and replicate water quality samples intended for quality control purposes should be specified as should the number of replicate biological samples. Analytical methods should also be specified.

It is particularly important that the intended data analysis techniques be described thoroughly. Applicants should take special care to utilize statistical techniques that are consistent with the data collection program. The report "Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters" provides additional guidance on all aspects of sampling and analysis.

As further assistance, the applicant can use the following outline to organize the plan of study.

Plan of Study Outline

A. Data Requirements
   1. Existing data
   2. Additional data required

B. Proposed Data Collection Program
   1. Sampling station location
      a. Location map
      b. Station coordinates
      c. Navigation method

   2. Sampling frequency
      a. Temporal frequency
      b. Water quality sample splits and replicates for quality control
      c. Biological sample replication

C. Sampling and Analytical Methods
   1. Sampling technique
   2. Sample preservation
   3. Analytical methods

4. Analytical quality control

D. Data Analysis
   1. Purpose of data analysis or statistical hypotheses to be tested
   2. Statistical methods
   3. Proposed format for presentation of results

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APPENDIX A

RELEVANT GOVERNMENT AGENCIES

Key

1. State Water Quality Agency
2. State Coastal Zone Management Agency
3. EPA Regional Office
4. National Marine Fisheries Service Regional Office
5. U.S. Fish and Wildlife Service Regional Office

APPENDIX A. RELEVANT GOVERNMENT AGENCIES

ALABAMA

1. Municipal Waste Control Section
   Alabama Water Improvement
   c/o Public Health Service Bldg.
   Montgomery, Alabama 36130
   (205) 277-3630

2. Alabama Coastal Area Board
   P. O. Box 755
   Daphne, Alabama 36526
   (206) 626-1880

3. EPA - Region IV
   345 Courtland Street, NE
   Atlanta, GA 30308
   (404) 881-4727

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd.
   St. Petersburg, FL 33702
   (813) 893-3141

5. USFWS Region 4 - Southeast
   75 Spring St., SW
   Atlanta, Georgia 30303
   (404) 221-3588

APPENDIX A. (continued)

ALASKA

1. Alaska Department of Environmental
   Conservation
   Water Quality Management Section
   Pouch O
   Juneau, AK 99811
   (907) 465-2653

2. Office of Coastal Management
   Pouch AP
   Juneau, AK 99801
   (907) 465-3540

3. EPA - Region X
   1200 Sixth Avenue
   Seattle, WA 98101
   (206) 442-1220

4. Alaska Regional Office
   NMFS
   P. O. Box 1668
   Juneau, AK 99802
   (907) 586-7221

5. Alaska Regional Office
   1011 Tudor Road
   Anchorage, AK 99503
   (907) 263-3542

APPENDIX A. (continued)

CALIFORNIA

1. California Water Resources Control
   Board
   P. O. Box 100
   Sacramento, CA 95801
   (916) 445-7762

2. California Coastal Commission
   631 Howard Street
   San Francisco, CA 94105
   (415) 543-8555

3. EPA - Region IX
   215 Fremont Street
   San Francisco, CA 94105
   (415) 974-8153

4. Southwest Regional Office
   NMFS
   300 S. Perry Street
   Terminal Island, CA 90731
   (213) 548-2575

5. USFWS Region I - Pacific
   500 N.E. Multonomah Street, Suite 1692
   Portland, OR 97232
   (503) 231-6158

APPENDIX A. (continued)

CONNECTICUT

1. Water Compliance Unit
   Department of Environmental Protection
   State Office Bldg.
   122 Washington Street
   Hartford, CT 06115
   (203) 566-3245

2. Coastal Area Management Program
   Department of Environmental Protection
   71 Capitol Avenue
   Hartford, CT 06115
   (203) 566-7404

3. EPA - Region I
   Room 2203
   John F. Kennedy Federal Bldg.
   Boston, MA 02203
   (617) 223-7210

4. Northeast Regional Office
   NMFS
   Federal Bldg.
   14 Elm Street
   Gloucester, MA 01930
   (617) 281-3600

5. USFWS Region 5 - Atlantic
   One Gateway Center
   Suite 700
   Newton Center, MA 02158
   (617) 965-5100

APPENDIX A. (continued)

DELAWARE

1. Water Resources Section
   Department of Natural Resources
   and Environmental Control
   State of Delaware
   P. O. Box 1401
   Dover, DE 19901
   (302) 736-4761

2. Dept. of Natural Resources and
   Environmental Control
   P. O. Box 1401/Edward Tatnell Bldg.
   Dover, DE 19901
   (302) 736-3091

3. EPA - Region II
   26 Federal Plaza, Room 900
   New York, NY 10007
   (212) 264-2525

4. Northeast Regional Office
   NMFS
   Federal Bldg.
   14 Elm St.
   Gloucester, MA 01930
   (617) 281-3600

5. USFWS Region 5 - Atlantic
   One Gateway Center, Suite 700
   Newton Center, MA 02158
   (617) 965-5100

APPENDIX A. (continued)

FLORIDA

1. NPDES Section
   Dept. of Environmental Regulations
   2600 Blair Stone Road
   Tallahassee, FL 32301
   (907) 487-1620

2. Office of Coastal Management
   Twin Towers Office Bldg.
   2600 Blairstone Road
   Tallahassee, FL 32301
   (904) 488-8614

3. EPA - Region IV
   345 Courtland Street, NE
   Atlanta, GA 30308
   (404) 881-4727

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./ Duval Bldg.
   St. Petersburg, FL 33702
   (813) 983-3141

5. USFWS Region 4 - Southeast
   75 Spring Street, SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

GEORGIA

1. Municipal Compliance and Technical Support Program
   Georgia Environmental Protection Division
   270 Washington Street, SW
   Atlanta, GA 30334
   (404) 656-7400

2. Coastal Resources Division
   Dept. of Natural Resources
   1200 Glynn Avenue
   Brunswick, GA 03520
   (912) 264-4771

3. EPA - Region IV
   345 Courtland Street, NE
   Atlanta, GA 30308
   (404) 881-4727

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33702
   (813) 826-3141

5. USFWS Region 4 - Southeast
   75 Spring Street, SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

HAWAII

1. Pollution Technical Review Branch
   Environmental Protection and
   Health Services Division
   Hawaii State Dept. of Health
   P. O. Box 3378
   Honolulu, HI 96801
   (808) 548-6410

2. Dept. of Planning and Economic
   Development
   P. O. Box 2359
   Honolulu, HI 96804
   (808) 548-4609

3. EPA - Region IX
   215 Fremont Street
   San Francisco, CA 94105
   (415) 974-8153

4. Northwest Regional Office
   NMFS
   7600 Sand Point Way, NE
   Seattle, WA 98115
   (206) 527-6150

5. USFWS Region I - Pacific
   500 NE Multnomah Street, Suite 1692
   Portland, OR 97232
   (503) 231-6158

APPENDIX A. (continued)

LOUISIANA

1. Division of Water Pollution Control
   Dept. of Natural Resources
   P. O. Box 44066
   Baton Rouge, Louisiana 70804
   (504) 342-6363

2. Coastal Resources Program
   P. O. Box 44398
   Capital Station
   Baton Rouge, Louisiana 78704
   (504) 342-7591

3. EPA - Region VI
   1201 Elm Street
   First International Bldg.
   Dallas, TX 95270
   (214) 767-2600

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33702
   (813) 893-3141

5. USFWS Region 4 - Southeast
   75 Spring Street, SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

MAINE

1. Division of Water Quality Evaluation and Planning
Dept. of Environmental Protection
State House
Augusta, ME
(207) 289-2591

2. Natural Resources Division
State Planning Office
184 State Street
Augusta, ME 04330
(207) 289-3261

3. EPA - Region I
John F. Kennedy Federal Bldg., Rm. 2203
Boston, MA 02203
(617) 223-7210

4. Northeast Regional Office
NMFS
14 Elm Street/Federal Bldg.
Gloucester, MA 01930
(617) 281-3600

5. USFWS Region 5 - Atlantic
One Gateway Center
Suite 700
Newton Center, MA 02158
(617) 965-5100

APPENDIX A. (continued)

MARYLAND

1. Municipal Permits Division
   Water Resources Administration
   Department of Natural Resources
   201 W. Preston Street
   Baltimore, MD 21201

2. Coastal Resources Division
   Dept. of Natural Resources
   Tawes State Office Bldg.
   Annapolis, MD 21401
   (301) 269-2784

3. EPA - Region II
   Sixth and Walnut Streets/Curtis Bldg.
   Philadelphia, PA 19106
   (215) 597-9814

4. Northeast Regional Office
   NMFS
   14 Elm Street/Federal Bldg.
   Gloucester, MA 01930
   (617) 281-3600

5. USFWS Region 4 - Atlantic
   One Gateway Center
   Suite 700
   Newton Center, MA 02158
   (404) 221-3588

APPENDIX A. (continued)

MASSACHUSETTS

1. Permits and Enforcement Section
   Division of Water Pollution Control
   One Winter Street
   Boston, MA 02108
   (617) 292-5668

2. Executive Office
   Environmental Affairs
   100 Cambridge Street
   Boston, MA 02202
   (617) 727-9530

3. EPA - Region I
   Room 2203/John F. Kennedy Federal Bldg.
   Boston, MA 02203
   (617) 223-7210

4. Northeast Regional Office
   NMFS
   Federal Bldg.
   14 Elm Street
   Gloucester, MA 01830
   (617) 281-3600

5. USFWS Region 5 - Atlantic
   One Gateway Center
   Suite 700
   Newton Center, MA 02158
   (617) 965-5100

APPENDIX A. (continued)

MISSISSIPPI

1. Water Division
   Bureau of Pollution Control
   Mississippi Dept. of Natural Resources
   P. O. Box 10385
   Jackson, MS 39209
   (601) 961-5171

2. Coastal Program Division
   P. O. Box 959
   Long Beach, MS 39560
   (601) 864-4602

3. EPA - Region IV
   345 Courtland Street, NE
   Atlanta, GA 30308
   (404) 881-4727

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33702
   (813) 893-3141

5. USFWS Region 4 - Southeast
   75 Spring Street, SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

NEW HAMPSHIRE

1. Permits and Surveillance Division
New Hampshire Water Supply and
  Pollution Control Commission
P. O. Box 95
Concord, NH 03301
(603) 271-3501

2. Office of State Planning
2-1/2 Beacon Street
Concord, CT 03301
(603) 271-2155

3. EPA - Region I
John F. Kennedy Federal Bldg., Room 2203
Boston, MA 02203
(617) 223-7210

4. Northeast Regional Office
NMFS
Federal Bldg.
14 Elm Street
Gloucester, MA 01930
(617) 281-3600

5. USFWS Region 5 - Atlantic
One Gateway Center
Suite 700
Newton Center, MA 02158
(617) 965-5100

APPENDIX A. (continued)

NEW JERSEY

1. Municipal Waste Management
   Division of Water Resources
   Department of Environmental Protection
   P. O. Box CN - 029
   Trenton, NJ 08625
   (609) 984-4429

2. Bureau of Coastal Planning and Development
   Dept. of Environmental Protection
   P. O. Box CN - 401
   Trenton, NJ 08625
   (609) 292-9762

3. EPA - Region II
   26 Federal Plaza, Room 900
   New York, NY 10007
   (212) 264-2525

4. Northeast Regional Office
   NMFS
   Federal Bldg./14 Elm Street
   Gloucester, MA 01930
   (617) 281-3600

5. USFWS Region 5 - Atlantic
   One Gateway Center/Suite 700
   Newton Center, MA 02158
   (617) 965-5100

APPENDIX A. (continued)

NEW YORK

1. Permit Administration
Department of Environmental Conservation
50 Wolf Road, Room 306
Albany, NY 12233
(518) 457-7499

2. Coastal Management Unit
Department of State
162 Washington Street
Albany, NY 12231
(518) 474-8834

3. EPA - Region II
26 Federal Plaza, Room 900
New York, NY 10007
(212) 264-2525

4. Northeast Regional Office
NMFS
14 Elm Street
Federal Bldg.
Gloucester, MA 01930
(617) 281-3600

5. USFWS Region 5 - Atlantic
One Gateway Center, Suite 700
Newton Center, MA 02158
(617) 965-5100

APPENDIX A. (continued)

NORTH CAROLINA

1. NPDES Program
   Environmental Operations Section
   Division of Environmental Management
   P. O. Box 27687
   Raleigh, NC 27611
   (919) 733-5191

2. Dept. of Natural Resources and
   Community Development
   Box 27687
   Raleigh, NC 27611
   (919) 733-2293

3. EPA - Region IV
   345 Courtland Street, NE
   Atlanta, GA 30309
   (404) 881-4727

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33202
   (813) 893-3141

5. USFWS Region 4 - Southeast
   75 Spring Street SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

OREGON

1. Water Quality Division
   Department of Environmental Quality
   1234 SW Morrison Street
   Portland, OR 97025
   (503) 229-6474

2. Dept. of Land Conservation and Development
   1175 Court Street NE
   Salem, OR 97310
   (503) 378-4097

3. EPA - Region I
   1200 Sixth Avenue
   Seattle, WA 98101
   (206) 442-1220

4. Northwest Regional Office
   NMFS
   7600 Sand Point Way, NE
   Seattle, WA 98115
   (206) 527-6150

5. USFWS Region 1 - Pacific
   500 NE Multnomah Street, Suite 1692
   Portland, OR 97232
   (503) 231-6158

APPENDIX A. (continued)

PUERTO RICO

1. Environmental Quality Board
   Box 11499
   Santurce, PR 00910
   (809) 725-5140

2. Department of Natural Resources
   P. O. Box 5887
   Puerta deTierra, PR 00906
   (809) 725-2769

3. EPA - Region II
   26 Federal Plaza, Room 900
   New York, NY 10007
   (212) 264-2525

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33702
   (813) 893-3141

5. USFWS Region 4 - Southeast
   75 Spring Street, SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

RHODE ISLAND

1. Division of Water Resources
Dept. of Environmental Management
209 Cannon Bldg.
75 Davis Street
Providence, RI 02908
(401) 277-2234

2. Coastal Resource Management Program
Washington County Government Center
Tower Hill Road
South Kingston, RI 02897
(401) 789-3048

3. EPA - Region I
John F. Kennedy Federal Bldg., Room 2203
Boston, MA 02203
(617) 223-7210

4. Southeast Regional Office
NMFS
9450 Koger Blvd./Duval Bldg.
St. Petersburg, FL 33702
(813) 893-3141

5. USFWS Region 4 - Southeast
75 Spring Street SW
Atlanta, GA 30303
(404) 221-3588

APPENDIX A. (continued)

SOUTH CAROLINA

1. NPDES Administration Section
   South Carolina Dept. of Health and
   Environmental Control
   2600 Bull Street
   Columbia, SC 29201
   (803) 748-3877

2. South Carolina Coastal Staff
   1116 Bankers Trust Tower
   Columbia, SC 29201
   (803) 758-8442

3. EPA - Region IV
   345 Courtland Street NE
   Atlanta, GA 30308
   (404) 881-4727

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33202
   (813) 893-3141

5. USFWS Region 4 - Southeast
   75 Spring Street SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

TEXAS

1. Permits Division
   Texas Dept. of Water Resources
   1700 North Congress
   P. O. Box 13087, Capitol Station
   Austin, TX 78701
   (512) 475-3345

2. Natural Resources Division
   Texas Energy and Natural Resources Council
   200 E. 18th Street
   Austin, TX 78701
   (512) 475-0073

3. EPA - Region VI
   1201 Elm Street
   First International Bldg.
   Dallas, TX 75270
   (214) 767-2600

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33702
   (813) 893-3141

5. USFWS Region 2 - Southwest
   500 Gold Avenue, SW
   Albuquerque, NM 87103
   (505) 766-2321

APPENDIX A. (continued)

VIRGINIA

1. State Water Control Board
   P. O. Box 11143
   Richmond, VA 23230
   (804) 257-6336

2. Council on the Environment
   Ninth Street Office Bldg.
   Richmond, VA 23219
   (804) 786-4500

3. EPA - Region III
   Curtis Bldg., Sixth and Walnut Streets
   Philadelphia, PA 19106
   (215) 597-9814

4. Northeast Regional Office
   NMFS
   Federal Bldg.
   14 Elm Street
   Gloucester, MA 01930
   (617) 281-3600

5. USFWS Region 5 - Atlantic
   One Gateway Center, Suite 700
   Newton Center, MA 02158
   (617) 965-5100

APPENDIX A. (continued)

VIRGIN ISLANDS

1. Dept. of Conservation and Cultural
   Affairs
   P. O. Box 4340
   Charlotte Amalie, St. Thomas, VI 00801
   (809) 774-6420

2. Dept. of Conservation and Cultural
   Affairs
   P. O. Box 4340
   Charlotte Amalie, St. Thomas, VI 00801
   (809) 774-6522

3. EPA - Region II
   26 Federal Plaza, Room 900
   New York, NY 10007
   (212) 264-2525

4. Southeast Regional Office
   NMFS
   9450 Koger Blvd./Duval Bldg.
   St. Petersburg, FL 33702
   (813) 893-3141

5. USFWS Region 4 - Southeast
   75 Spring St. SW
   Atlanta, GA 30303
   (404) 221-3588

APPENDIX A. (continued)

WASHINGTON

1. NPDES Program
   Department of Ecology
   State of Washington
   Olympia, WA 98504
   (206) 459-6078 (6042)

2. Department of Ecology
   State of Washington (PY-11)
   Olympia, WA 98504
   (206) 459-6273

3. EPA - Region X
   1200 Sixth Avenue
   Seattle, WA 98101
   (206) 442-1220

4. Northwest Regional Office
   NMFS
   7600 Sand Point Way, NE
   Seattle, WA 98115
   (206) 627-6150

5. USFWS Region 1 - Pacific
   500 NE Multnomah Street, Suite 1692
   Portland, OR 97232
   (503) 231-6158

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